AGRICULTURAL ENGINEERING

Published monthly by the American Society of Agricultural Engineers

at the headquarters of the Society

54 North Avenue, Mount Clemens, Michigan, U. S. A.

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to the members of the Society, $2.00 a year, 20 cents a copy. Postage to Canada, 50 cents additional; to foreign countries, $1.00 additional. Entered as second-class matter, November 7, 1923 at the post office at Mt. Clemens, Michigan, under Act of August 24, 1912. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title "Agricultural Engineering" is registered in the U. S. Patent Office.

S. H. McCRORY, President RAYMOND OLNEY, Secretary-Treasurer

Vol. 5 MAY, 1924 No. 5

CONTENTS

EDITORIALS 99

THE EIGHTEENTH ANNUAL A. S. A. E. MEETING 100

THE GENERAL PURPOSE FARM TRACTOR 102
By F. A. Wirt

OVERCOMING SALES RESISTANCE TO MODERN FARM EQUIPMENT AN ENGINEERING PROBLEM 105
By W. B. Clarkson

RESEARCH METHODS IN AGRICULTURAL ENGINEERING 107
—Research in Agricultural Engineering
By R. W. Trullinger

SURVEY OF AGRICULTURAL ENGINEERING PROGRESS 112
By R. W. Trullinger

A. S. A. E. AND RELATED ENGINEERING ACTIVITIES 114

Statements of facts or opinions advanced in original articles, papers or discussions are not sponsored by the Society as a body. Original articles, papers, discussions and reports may be reprinted from this publication provided proper credit is given.

The Object and Scope of A. S. A. E. Activities

THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

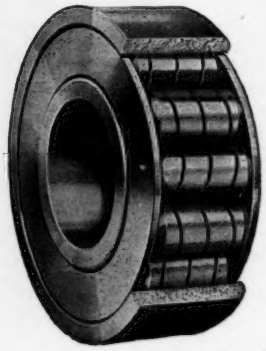
The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.
(b) Farm Structures—buildings and other structures and related equipment.
(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.
(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.
(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.

Member American Engineering Council

SOMETHING TO BE REMEMBERED:



When you specify Hyatt Roller Bearings in your tractor or implement you are safeguarding your judgment. No Hyatt Roller Bearing ever required adjustment and they have been used for years and years by the oldest and largest manufacturers with complete satisfaction.

HYATT ROLLER BEARING CO.

DETROIT	CHICAGO	NEWARK		SAN FRANCISCO
New York	Worcester	Cleveland	Milwaukee	Buffalo
Pittsburgh	Huntington	Minneapolis	Philadelphia	Indianapolis

HYATT

ROLLER BEARINGS

AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

RAYMOND OLNEY, M. E., A. E., Editor

Vol. 5 MAY, 1924 No. 5

Get Behind the Temple Bill

THE Temple Bill to complete the topographic map of the United States in twenty years is again hung up in committee in Congress. It will be remembered that the following resolution was passed at the last annual meeting of the Society:

"Whereas, agricultural engineers make constant use of topographic maps, often finding those now published by the federal government to be of great service, and

"Whereas, the government has been engaged in making a general utility topographical map of the United States for over forty years and has so far covered adequately less that forty per cent of the area,

"BE IT RESOLVED that suitable congressional action be taken to insure the completion of a general utility map of the United States during this generation. Such action would establish a constructive policy of service to many industries and to the public generally.

"AND BE IT FURTHER RESOLVED that the Secretary of this Society be directed to send a copy of these resolutions to the President of the United States, especially requesting him to make such recommendation as contained in the above resolutions in his next message to Congress."

Recently a meeting of the Board of Surveys and Maps of the federal government, on the advisory council of which this society is represented in the person of John R. Haswell, was held in Washington, at which time it was shown that eighteen different map-making agencies are making an effort to get together and do some real cooperative work.

Engineers of the country are urging that the Temple Bill be given a hearing at the earliest possible date. It is urged, therefore, that members of the American Society of Agricultural Engineers get in touch with their senators and representatives in Congress, either by letter or personal interview, and urge that pressure be brought to bear upon the Interstate and Foreign Commerce Committee of the House of Representatives to give the bill a hearing. The bill has had the habit of dying in committee in years past. We don't know how many lives the Temple Bill has, but it would seem that engineers acting as a unit would be successful in securing not only a hearing on the bill but the passage of it as well. Let us as agricultural engineers respond to the call and help put this worthy project through.

Permanent Lumbering

WHAT appears to be a real beginning of permanent lumbering practice appears in the announcement to the effect that eight of the largest lumber manufacturing and timber-owning corporations on the Pacific Coast have inaugurated comprehensive and widespread forestry investigations with the view of the introduction of forestry management of their timber holdings. It is impossible to overestimate the economic significance to the American people, and especially to the agricultural interests which are the largest users of lumber products, of such a movement. In all probability the inauguration of this investigation means that these leaders in the lumber industry will inaugurate forestry management, reforestation, and perpetual lumbering on their tracts, and that their example will be followed very generally by other lumber interests.

Agricultural engineers especially are interested in any movement which has for its object insuring the permanent lumber supply of the country; in fact, agricultural engineers should let no opportunity pass to encourage reforestation and permanent lumbering practice, both of which have been almost criminally neglected in this country. Not only is permanent lumbering practices and reforestation desirable on a large scale, by timber-owning corporations, and by state and federal governments, but also in connection with the woodlots on individual farms. This, perhaps, is where the influence of the agricultural engineer is most needed, as the development and improvement of the farm woodlot is most important from the standpoint of the farmer's future timber supply.

Who Are the Elect?

RESEARCH is in the air. The A. S. A. E. Research Committee inspires us by its articles. We see examples daily of where worthy commercial application is made of the results of valuable investigations. All agricultural engineers, if they are worthy of the name, desire to organize and conduct worth while experimentation and research. But to whom is this privilege extended. Who are the elect?

Many of the world's most important discoveries and inventions would yet be hidden if their authors had waited to begin until time and money were made available. If you are still shivering on the bank of the research pond, kick off the ball and chain and jump in. And then do not float on the water wings of overelaborate plans, procrastination, lack of time or money, but start swimming.

Every member of a college or university agricultural engineering division (or whatever alias such an organization may be traveling under) should be earnestly encouraged (pronounced "required") to interest himself in this vital phase of the institution's activities. It is fully realized that in some educational institutions there is a separate experiment station. They do not, however, hold the basic patents on research. In many institutions it is undoubtedly true that each member of the staff should be twins even to keep up with his teaching and extension activities. Unfortunately there is no mystic way by which the experiment station worker can connect with the teacher or extension man giving him the results of his work or, what is more important, the desire to separate facts from fancy.

Not so loud, please! I heard your "How can I do it?"

1. Select an unsolved agricultural engineering problem.
2. Study it; learn all that exists about it (and do not think that all investigation is carried on in the United States); brush up on those fundamentals of physics, mathematics, etc., that pertain to it. With most of us, this of necessity will be a long process.
3. Start, even though it wrecks some of the red tape. "Love will find a way."

Your students will rejoice and wonder what has awakened you. (Good instruction or extension is based on the possession of the research spirit). No longer will you be quoting to your classes the wonders of the Sunday supplement automobile section. It will cause you to sift carefully hearsay and local opinions; it will instill the desire for real facts and truth into your students. They need it—the country needs it.

Read regularly one or two good research periodicals. It matters little whether the subject is love, lubrication or lockjaw; get the method, the spirit of it all.

It has been said there is no new truth; truth always existed; it is ready for you to find it; all it needs is uncovering.

Who then are the elect? You are, if you cast a unanimous ballot for yourself and at once take up the duties of the office..

L. J. FLETCHER

The Eighteenth Annual A. S. A. E Meeting

A TENTATIVE program of the annual meeting will be found on the following page—page 102. It is not yet complete, and some changes will be made. Watch the June issue of AGRICULTURAL ENGINEERING for the final program.

A great deal of enthusiasm has been filtering through to the Secretary's office the past several weeks in anticipation of this year's annual meeting program. Without question it is the best one the Society has yet offered. Members of the Society who do not attend the meeting at Lincoln next month will be missing one of the biggest events in the history of agricultural engineering development. Every agricultural engineer should attend if it is humanly possible for him to do so.

Don't be satisfied with coming yourself; encourage others who are interested in agricultural engineering to attend also. If the expense of the trip is a factor, weigh it in the scale with your professional advancement, and you will find it a small factor in comparison. Let every agricultural engineer who is seriously interested in advancing his profession, which is so closely related to his own personal interest and progress, take up the cry "On to Lincoln!" Let's be there five hundred strong!

All members should attend the Lincoln meeting to keep in touch with the advancement being made and, incidentally, to receive the benefits that only such meetings afford in the way of getting new inspiration and ideas.

While the annual meeting does not officially open until June 18, especial attention is called to the very interesting events scheduled for the day previous (June 17), which has been set aside for committee meetings, round-table conferences, excursions, and demonstrations that have been arranged for the special benefit of all who are interested in agricultural engineering whether they be members of the Society or not.

All who are especially interested in reclamation and wish to take the reclamation tour June 17 should notify Prof. I. D. Wood, College of Agriculture, Lincoln, Nebraska, before June 10. Members who are interested in reclamation are invited to make the tour of southeastern Nebraska, where visits will be made to large soil saving dams, terraced fields, ditches controlled by brush dams, and tile drained fields. It is planned that this tour will take the entire forenoon and part of the afternoon of June 17. The rest of the day will be devoted to a round-table conference of reclamation at the College of Agriculture and dinner in the evening.

The reclamation projects that will be visited are at Ashland, Nebraska, twenty-five or thirty miles east of Lincoln. Automobiles will meet Burlington train No. 5 at Ashland at 9:25 A. M. Ashland is the starting point on the tour and all persons from north and east should leave Omaha on Burlington train No. 5 at 8:25 A. M. an dstop at Ashland. Other cars will leave the Agricultural Engineering Building at the College of Agriculture campus at 8:15 A. M. to accommodate members arriving on early morning trains. It is important that those who intend making this tour notify Prof. Wood before June 10, giving full information as to the time of their arrival in Lincoln and on what trains.

A tractor demonstration will be put on by the Nebraska test engineers, Prof. E. E. Brackett, F. R. Nohavec, and their assistants. These tests will consist of belt and drawbar tests with such other special tests as there may be time for. The construction laboratories will all be open and equipment will be on display. It is proposed to conduct some of the tractor drawbar tests at the indoor earth plat so that the method of procedure may be observed.

The Committee on Local Arrangements has also made arrangements with the agronomy department of the University to give a short excursion through its field plats showing the effects of various methods of tillage, time for seeding different types of grain, etc. This will also include a trip to the agronomy farm about five miles from the campus.

A meeting of the Advisory Committee of the College Division of the Society is scheduled for the afternoon of June 17.

A meeting of the Council, including the retiring and incoming members, is scheduled for the evening of June 17.

If there are other groups interested in holding meetings or round-table conferences on June 17, arrangements should be made with Prof. O. W. Sjogren, chairman of the Committee on Local Arrangements, or with the Secretary of the Society.

The annual meeting will open at 9:00 A. M. on June 18, with simultaneous programs of the Farm Power and Machinery Division and the Reclamation Division. The formal opening of the meeting, however, will not take place until the general session at 2:00 P. M. on June 18, when it will be opened by introductory remarks by Prof. Sjogren, chairman of the Committee on Local Arrangements, followed by the President's annual address, and following that by an address by H. J. Hirschheimer, president of the National Association of Farm Equipment Manufacturers.

Beginning again at 3:00 P. M. the simultaneous programs of the Farm Power and Machinery Division and the Reclamation Division will be continued.

The annual business meeting of the Society will be held at 8:00 P. M. on June 18. Business of the utmost importance, as it relates to the future growth and activities of the Society, will come before the meeting and members are urged to permit nothing to interfere with their attendance at this meeting.

Two simultaneous sessions will run throughout the second day, June 19, of the meeting. These are the rural electrification program and the farm structures program. As on the first day, however, a general session, in which the entire convention will take part, will be held from 2:00 to 3:00 P. M., at which time a speaker of national prominence, who has not been selected at this writing, will address the meeting, probably on the subject of "Reclamation and Recreation."

The annual banquet will be held the evening of June 19 at 7:00 P. M. at the Chamber of Commerce.

It is certain that those who attended the annual meeting last November in Chicago will not miss the banquet this year. The annual A. S. A. E. banquet is a fitting climax to the program that has preceded—an event full of inspiration and good fellowship that no member in attendance can afford to miss. From information received from the chairman of the Committee on Local Arrangements, the banquet tickets this year will probably be $2.00 a plate. At our last annual banquet members furnished their own entertainment and all who attended were unanimously agreed that it had professional entertainers backed off the boards.

The entire third day, June 20, will be devoted to the Educational or College Division program, which will deal with the various phases of resident teaching, research, and extension. The morning session, beginning at 9:00 A. M., will be devoted largely to a discussion of research problems in agricultural engineering. The forenoon will be devoted principally to resident teaching, while the evening session, under the direction of H. H. Sunderlin, chairman of the Committee on Agricultural Engineering Extension will be devoted exclusively to agricultural engineering extension problems.

The part of the extension program, which it is expected will take the greater part of the time scheduled, is that of a frank open discussion by the extension men and others as to what their problems are and their possible solution. It is this part of the program which should be of the greatest benefit to those engaged in extension work and all exten-

(Continued on page 120)

Tentative Program of the 18th Annual Meeting

Lincoln, Nebraska—June 18, 19, and 20, 1924

THE official opening of the meeting will be June 18; the day previous (June 17), however, has been set aside for committee meetings, round-table conferences, excursions and demonstrations. With the exception of the last day, two divisions will be in session simultaneously. Each day, from 2:00 to 3:00 P. M., a general session will be held, at which time a speaker of national prominence will address the entire convention. The annual business meeting will be held during the evening of June 18, and the annual banquet on the evening of June 19.

June 17

Reclamation tour of southeastern Nebraska
Tractor testing (belt and drawbar) demonstration
Excursion to the agronomy farm of the University of Nebraska
Meeting of the Advisory Committee of the College Division
Council meeting (evening)

First Day—June 18

GENERAL SESSIONS

2:00 P. M. Introductory Remarks: O. W. Sjogren, chairman, Committee on Local Arrangements
President's Annual Address: S. H. McCrory, chief, division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture
ADDRESS: H. J. Hirschheimer, president, National Association of Farm Equipment Manufacturers, and president, La Crosse Plow Company
8:00 P. M. ANNUAL BUSINESS MEETING

FARM POWER AND MACHINERY PROGRAM

MORNING SESSION—9:00 A. M.

PAPER: "Power, Machinery and Production." (Results of U. S. D. A. nation-wide study on power requirements of different crops, especially corn.) C. D. Kinsman, division of agricultural engineering, U. S. Department of Agriculture
PAPER: "What California Confidentially Thinks About Tractor Design"—L. J. Fletcher, professor of agricultural engineering, University of California
PAPER: "The Manless Plow"—J. B. Davidson, professor of agricultural engineering, Iowa State College
PAPER: "Motorizing the Corn Crop in Ohio"—G. W. McCuen, professor of agricultural engineering, Ohio State University
PAPER: "Growing 1000 Acres of Corn on the Hawthorne Farm in Illinois"

AFTERNOON SESSION—3:00 P. M.

PAPER: "Economical Production of Corn in Kansas"—W. E. Grimes, professor of agricultural economics, Kansas State Agricultural College
PAPER: "Cutting Silage in the Field or at the Silo Filler"—C. D. Parsons, department of agricultural engineering, University of Nebraska
PAPER: "Growing Corn With Horse Power"

RECLAMATION PROGRAM

MORNING SESSION—9:00 A. M.

PAPER: "The Irrigation Problem in Kansas"—Geo. S. Knapp, state irrigation commissioner of Kansas
Discussion—S. H. Beckett, professor of irrigation practice, University of California
PAPER: "The Relation Between Clearing Cut-Over Land and the Development of a Forestry Program"—N. A. Kessler, land clearing specialist, Michigan Agricultural College
REPORT: Committee on Drainage—J. R. Haswell, extension agricultural engineer, Pennsylvania State College, chairman

AFTERNOON SESSION—3:00 P. M.

PAPER: "New Developments in Salvaged War Explosives"—W. A. Rowlands, land clearing section, department of agricultural engineering, University of Wisconsin
REPORT: Committee on Land Clearing—L. F. Livingston, land clearing specialist, Michigan Agricultural College, chairman
REPORT: Committee on Land Settlement—Wallace Ashby, agricultural engineer, Duluth and Iron Range Railroad, chairman
REPORT: Committee on Soil Erosion—E. W. Lehmann, professor of farm mechanics, University of Illinois, chairman

Second Day—June 19

GENERAL SESSIONS

2:00 P. M. Address: "Reclamation and Recreation"—(speaker not yet selected.)
7:00 P. M. ANNUAL BANQUET

RURAL ELECTRIFICATION PROGRAM

MORNING SESSION—9:00 A. M.

PAPER: "An Investigation Program on the Relation of Electricity to Agriculture"—R. W. Trullinger, specialist in rural engineering, Office of Experiment Stations, U. S. Department of Agriculture
Discussion—L. J. Fletcher, University of California
M. L. Nichols, Alabama Polytechnic Institute
E. A. Stewart, University of Minnesota
H. B. Walker, Kansas State Agricultural College
J. B. Davidson, Iowa State College
PAPER: "Electricity in Agriculture Abroad"—P. A. Lundquist, chief, electrical equipment division, U. S. Department of Commerce
REPORT: Committee on Rural Power Lines—C. A. Atherton, engineer, National Lamp Works (General Electric Company), chairman

AFTERNOON SESSION—3:00 P. M.

PAPER: "The Relation of Water Power to Electrical Development"—G. C. Neff, general manager, Wisconsin River Power Company
PAPER: "Making Electrical Contact With the Farmer"—J. P. Fairbank, division of agricultural engineering, University of California
PAPER: "The National Farm Power Survey"—C. D. Kinsman, division of agricultural engineering, U. S. Department of Agriculture

FARM STRUCTURES PROGRAM

MORNING SESSION—9:00 A. M.

PAPER: "To What Extent May Farm Houses Be Standardized"—Walter G. Ward, extension architect, Kansas State Agricultural College
PAPER: "The Spacing of Posts in Barns and Feeding Sheds as Affected by the Turning Radius of Various Vehicles"—Erwin K. Young, Ohio State University
REPORT: Committee on Farm Building Ventilation—M. A. R. Kelley, agricultural engineer, U. S. Department of Agriculture, chairman

AFTERNOON SESSION—3:00 P. M.

REPORT: Committee on Farm Building Equipment—D. G. Carter, professor of agricultural engineering, University of Arkansas, chairman
REPORT: Committee on Farm Building Design—W. A. Foster, professor of agricultural engineering, University of Georgia, chairman
REPORT: Committee on Farm Sanitation—H. B. Walker, professor of agricultural engineering, Kansas State Agricultural College, chairman
REPORT: Committee on Farm Home Equipment—E. A. Stewart, professor of agricultural physics, University of Minnesota, chairman
REPORT: Committee on Farm Storage—K. J. T. Ekblaw, agricultural engineer, Portland Cement Association, chairman

Third Day—June 20

COLLEGE DIVISION PROGRAM

MORNING SESSION—9:00 A. M.

PAPER: "The Fundamentals of Research"—Dr. E. W. Allen, Office of Experiment Stations, U. S. Department of Agriculture
Discussion—J. B. Davidson, professor of agricultural engineering, Iowa State College
REPORT: Committee on Research of the College Division—R. W. Trullinger, chairman
REPORT: Advisory Committee of the College Division—D. Scoates, chairman
REPORT: Committee on Cooperative Relations, H. B. Walker, chairman
REPORT: Committee on Student Branches—J. B. Davidson, chairman
REPORT: Committee on Standardization of Blue Print Service—F. W. Ives, chairman

AFTERNOON SESSION—2:00 P. M.

PAPER: "Thought Processes and How We Learn"—Dr. William Elmer Sealock, dean of the teachers college and professor of history and principles of education, University of Nebraska
Discussion: F. W. Ives, professor of agricultural engineering, Ohio State University
REPORT: Committee on Teaching Methods—C. O. Reed, chairman
REPORT: Committee on Standardization of Courses—C. W. Smith
REPORT: Committee on the Advancement of Agricultural Engineering Education—F. W. Ives, chairman
REPORT: Committee on Aims and Objectives of the Agricultural Engineering Curriculum—J. B. Davidson, chairman

EVENING SESSION—8:00 P. M.

PAPER: "Aims and Objectives of Agricultural Engineering Extension"—R. L. Patty, extension agricultural engineer, South Dakota State College
REPORT: Committee on Agricultural Engineering Extension—H. H. Sunderlin, Iowa State College
DISCUSSION: "Pertinent Field Problems"—Agricultural engineering extension workers
Demonstration and inspection of Nebraska system of keeping office extension records—I. D. Wood, in charge

The General Purpose Farm Tractor*

By F. A. Wirt

Mem. A. S. A. E. Manager Sales Promotion, J. I. Case Threshing Machine Company

BEFORE discussing the reasons why the next big development in the tractor industry is expected to be a general-purpose tractor, definition of just what is indicated by the term "general purpose" will be in order.

By general-purpose tractor is meant an efficient source of mechanical power that can be used not only for customary tractor drawbar and belt operations, but also, when properly equipped and adjusted, for efficient cultivating, and other light drawbar work now more commonly done with horses. The outstanding feature of the general-purpose tractor, therefore, will be its effectiveness as a cultivator. Capacity for efficient plowing and belt work may be assumed.

Examination of the ever increasing use of labor-saving, time-saving, larger crop-producing farm machinery indicates continual progress. It is like carrying coals to Newcastle to discuss in a meeting of agricultural engineers the many beneficial results brought about by the change from hand to machine methods in American agriculture, but study of the results of using machinery emphasizes strongly the necessity for a general-purpose tractor. This same study also explains why the general-purpose tractor is a logical development.

It is quite generally assumed that the year 1850 marks the beginning of the change from hand to machine methods in agriculture. You are all familiar with the statement which appears in the Twelfth Census Report: "The year 1850 practically marks the close of the period in which the only farm implements and machinery, other than the wagon, cart, and cotton gin, were those which, for want of a better designation, may be called implements of hand production."

A most interesting confirmation of the above statement is found in the "Farmer's Everyday Book," published by Rev. John A. Blake of New York state in 1851. Mention is made of only the "plough, harrow, hoe, rake, fork, wagon, cart, and the like." Reference was made to the roller, an implement "but little known." Rev. Blake described how such a roller could be crudely constructed out of logs and heavy timbers.

Intensely interesting also is a 74-year old sale bill, now in the collection of the Old Oregon Trail Souvenirs at Lewiston, Oregon. On March 1, 1849, J. L. Moss, of Versailles, Kentucky, held a sale preliminary to starting on his jurney across the plains to "Oregon Territory" in an ox-drawn vehicle. Among the items put on sale were "2 ox carts, 1 iron plow with wood mold board, 2 spinning wheels, 1 large loom, one dozen real hooks, 2 handled hooks, 2 scythes and cradles, and one dozen wooden pitchforks."

About 73 years ago then this far-reaching change from hand methods to machine methods began. Prior to 1850 the farmers for centuries, for thousands of years, in fact, used methods which history says were startlingly similar, but since 1850 and in less than three quarters of a century, marvelous changes have been wrought.

Progress in the use of better machinery, as was to be expected, was very slow immediately following 1850. Labor-saving machines were crude in design and construction, but the great need for effective machinery to help in putting into production the rapidly developing Ohio, Mississippi, and Missouri valleys and watersheds, urged farmers and others of mechanical mind to work faster in the development of needed farm machinery.

In spite of human opposition in many quarters to advancement and to better methods which labor-saving machinery faced then as it is facing today, the application of machinery to agriculture gradually gathered momentum. Slowly at first, it is true, but as the years rolled by this movement increased until today we are justified in saying that the success of American farming depends absolutely upon the efficient use of modern, labor-saving farm operating equipment, but uniform progress has not been made in the different kinds of equipment.

Briefly stated, the happy results of using modern equipment include: The farmer is no longer the "man with the hoe," but is a business man greatly improved physically and mentally over farmers of centuries ago; the hours of work per day on the farm have been steadily reduced; returns for work done have increased; women as farm laborers hardly exist today; population has shifted from the farm to the cities, reducing the percentage of farm population from 90 per cent to less than 29 per cent, bringing with this shift the conveniences and many of the necessities of present day civilization; production per acre, also the production per man, which is vastly more significant, has been increased; production costs have decreased, and the quality of farm products has improved.

Running like a golden thread through this change from hand to machine methods is the outstanding fact that all development has been towards increasing the individual's capacity through control of more power and larger machinery. But that capacity great as it is today is limited because a general-purpose tractor is not available. It seems reasonable, therefore, to believe that a general-purpose tractor is a logical development in farm operating equipment.

When actual farm operating conditions are carefully examined, the need for general-purpose tractors stands out prominently. Farm operations can be classified as follows: Preparation of the seedbed, planting the seedbed, cultivating, harvesting, belt work, and miscellaneous. Reference to average operations on the average farm indicates that horses are necessary for planting seedbeds, cultivating row crops, harvesting most crops except wheat, and miscellaneous hauling.

Tractors, as we know them today, are most suitable for preparation of seedbeds, harvesting wheat and belt operations.

Reference to the following table giving the yearly farm operation on an average tractor farm is illuminating as to the possibilities of a general-purpose tractor: The usual source of power on efficient farms is also specified.

1. Preparation of seedbed (Spring):
   - (a) Plowing . . . . . Tractor power
   - (b) Disking . . . . . Tractor power
   - (c) Harrowing . . . . . Tractor power
2. Planting the seedbed:
   - (a) Drilling grain or seed . . . . . Horse power
   - (b) Planting grain or seed . . . . . Horse power
   - (c) Planting potatoes, etc. . . . . Horse power
3. Cultivating row crops:
   - (a) Cultivating . . . . . Horse power
4. Harvesting all crops:
   - (a) Cutting small grain . . . . . Tractor or horse power
   - (b) Mowing hay . . . . . Horse power
   - (c) Loading hay . . . . . Horse or tractor power
   - (d) Cutting corn . . . . . Horse power
   - (e) Digging potatoes . . . . . Horse power
5. Preparation of seedbed (Fall):
   - (a) Plowing . . . . . Tractor power
   - (b) Disking . . . . . Tractor power
   - (c) Harrowing . . . . . Tractor power
6. Belt operations:
   - (a) Threshing . . . . . Tractor power
   - (b) Silo filling . . . . . Tractor power
   - (c) Feed Grinding . . . . . Gas engine or tractor power
   - (d) Wood sawing . . . . . Gas engine or tractor power

*Paper presented at the 17th annual meeting of the American Society of Agricultural Engineers, Chicago, November 1923.

(e) Baling . . . . . Tractor power
(f) Shelling . . . . . Tractor power
(g) Shredding . . . . . Tractor power

7. Miscellaneous:
(a) Orchard spraying . . . . . Horse power
(b) Spreading manure . . . . . Horse or tractor power
(c) Hauling . . . . . Horse power

The present tractor owner uses the tractor in preparing the seedbed; then he uses horses for planting and cultivating while the tractor is usually idle. When harvesting the tractor may be used some. For belt operations, the tractor is gotten out, also for preparation of seedbeds in the fall. Miscellaneous operations require horses.

Examination of several tractor investigations discloses the interesting fact that the present tractor owner disposes on an average of only 2.8 horses per tractor. It should be explained in this connection that the number of horses disposed of differs widely, not only by states but also by individuals. Many owners of 15-27 tractors, for instance, dispose of six to eight horses upon the purchase of the tractor. After making due allowance for the tractor owners who prefer to increase their operations materially rather than sell horses, and other farmers who were under-powered before buying a tractor, it would seem that large numbers of farmers find it necessary to maintain both tractor and horses, the latter in a larger number than desirable. To maintain a tractor and horses on thousands of farms is too big a burden. They do not have sufficient work to justify buying a tractor for only a part of the farm work.

Further study of the foregoing table showing farm operations and power most often used emphasizes the relationship of type of farming to number of tractors sold. In the winter wheat belt and prairie rice territories, tractors, as might be expected, are used in great numbers but in the corn and cotton states where cultivating, and to a lesser extent, other light drawbar operations play a more important part in farm management, fewer tractors, relatively, are found.

Diversified farming is highly recommended, with few exceptions, by most farm management authorities, yet diversified farming means more cultivation and more light drawbar work, operations for which the present tractor is unsuited.

The importance of row crops can be better understood by reference to the major crops grown in United States as follows, the figures being taken from the 1922 U. S. D. A. year book:

Acreage of Grain and Row Crops

Wheat	61,230,000	Corn	102,428,000
Oats	40,693,000	Cotton	33,742,000
Barley	7,390,000	Grain sorghums (kafirs, milo, maize, feterita)	5,051,000
Rye	6,210,000	Potatoes	4,331,000
Flax	1,308,000	Tobacco	1,725,000
Rice	1,055,000	Sweet potatoes	1,116,000
Buckwheat	785,000	Sugar Beets (harvested)	537,000
		Cane	521,000
Total Acreage of Grain Crops	118,671,000	Total Acreage of Row Crops	149,451,000

Value of Grain and Row Crops

Wheat	$864,139,000	Corn	$1,900,287,000
Oats	478,548,000	Cotton	1,192,461,000
Barley	97,751,000	Grain sorghums (kafirs, milo, maize, feterita)	79,389,000
Rye	66,085,000	Potatoes	262,608,000
Flax	25,869,000	Tobacco	306,179,000
Rice	39,178,000	Sweet potatoes	84,492,000
Buckwheat	13,312,000	Sugar beets	29,605,000
		Broom corn	7,614,000
Total Value of Grain Crops	$1,584,882,000	Total Value of Row Crops	$3,862,635,000

Soy beans and cow peas are omitted from the foregoing table as they are planted both broadcast and in rows.

The row crops mentioned occupied, in 1922, 30,780,000 acres more than grain crops. After allowing for the vicissitudes of nature and shifts from one crop to another, it can reasonably be said that row crops occupy year after year a larger acreage than grain crops by many million acres. As far as value is concerned, row crops in 1922, as given above, were worth $2,277,753,000 more than the grain crops. Further explanation of the pressing need for a good general-purpose tractor sems unnecessary.

Farm help is difficult to get because of high wages paid in the cities. Floating labor from the city is more or less unavailable while, in the farming communities, the movement from the farm to the city keeps the supply of extra help exhausted. Wages for either good or bad farm hands is almost prohibitive. The farmer, therefore, must do the best he can with a minimum of help. With cultivating and harvesting overlapping, the farmer now finds himself in difficulties. A general-purpose tractor, obviously, would greatly increase the individual's capacity when he needs it most.

Granting that a very real need for a general-purpose tractor exists, the question immediately arises: What about the motor cultivator? While this is a controversial subject, the answer many will agree on is probably like this: For cultivating they have been quite efficient, but are lacking in power. They are too expensive for many farmers to buy, and they are lacking in the universality of uses which justify their purchase on a large scale. As for motor cultivators, with plowing attachments, they seem lacking in four essentials—adaptability, durability (dependability), economy, and ease of handling. The sale of motor cultivators, therefore, is greatly limited.

The farmer has two big jobs, plowing and cultivating, with harvesting a close second. Power is needed for plowing—speed for cultivating. To be thoroughly practical a general-purpose tractor must be efficient for both classes of work.

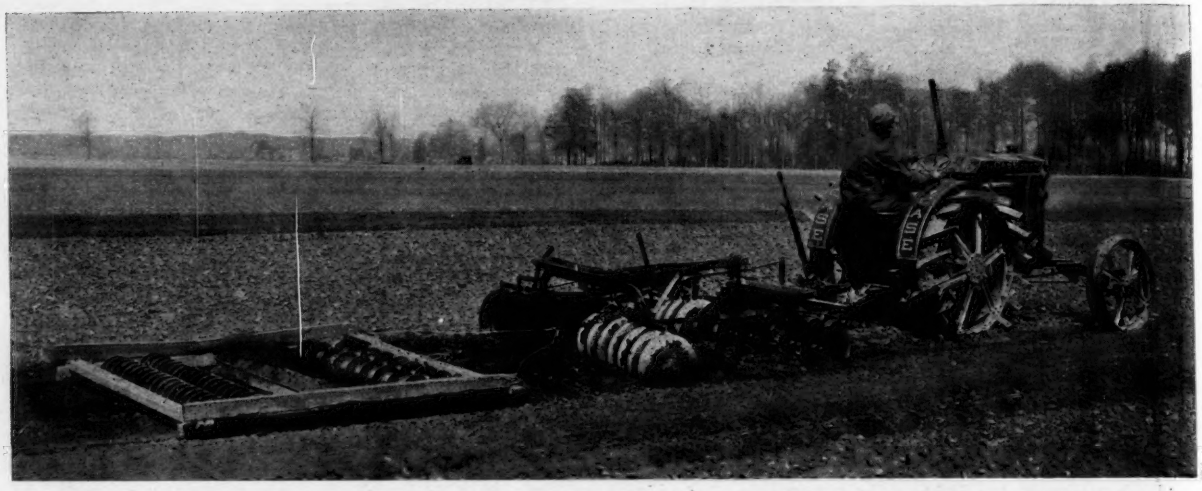
Right here is where a fundamental mistake is being made. The assumption is made that since a general-purpose tractor must be efficient in cultivating, the designer must consider cultivating of first importance and plowing of secondary importance. This faulty reasoning has led to motor cultivators with insufficient power, and, if not guarded against, will postpone the development of needed general-purpose tractors for years or until the mistake is rectified.

It would seem very desirable to lay the foundation of a general-purpose tractor on the fact that plowing and threshing requires more power than cultivating.

A wrong conception in other quarters which is noticeably retarding the development of a general-purpose tractor is the idea that a one-plow tractor is large enough to operate a two-row cultivator. Such a machine would be going backward. It does not increase the individual's capacity, which is contrary to the development of power and machinery, since the change from hand to machine methods. Of more practical consideration is the fact that a one-plow tractor does not have sufficient power to pull a two-row cultivator.

In my opinion a general-purpose tractor should pull a two 14-inch bottom plow under average conditions, operate a 20 or 22-inch thresher, and with the proper attachment cultivate two rows at a time. An attachment of lesser importance would be a 6, 7, or possibly an 8-foot mower for the general-purpose tractor could easily pull two mowers. When such a general-purpose tractor is designed and built, the additional power and weight necessary for pulling the two plows will not be found harmful nor too expensive in cultivating.

In using a general-purpose tractor, the tractor would be used for plowing and other seedbed work in the spring. Just prior to the planting season, on some rainy forenoon, for example, the necessary attachments or adjustments for planting could be added or made. Later the planting attachments could be shifted for cultivating equipment, and from then on only gangs need be removed when the general-purpose tractor is pulling the binder, hay loader, sprayer and other machines. The mowing attachment could be attached or removed easily when the time came for its use.



The general-purpose farm tractor must do more than plow and prepare the seedbed, haul binders, and perform various belt operations; it must be adapted to the planting and cultivating of row crops as well

When the fall plowing season came around the cultivating equipment could be removed and any necessary adjustments made for plowing.

In July, 1923, a letter was mailed to many college and university agricultural engineers asking for their answers to the following questions:

What, in your opinion, will be the next development in tractor development?

(a) Larger proportion of two-plow tractors?

(b) Larger proportion of three-plow tractors?

(c) A general-purpose tractor which cannot only be used successfully for plowing, but also for belt work and two-row cultivating?

A large number, as might be expected, qualified their replies. Others confined their opinions to their own local conditions; others based their replies on the industry as a whole.

Out of twenty replies, six favored the two-plow tractor, six the three-plow tractor, and thirteen a general-purpose tractor as the next development. Please note that six and six and thirteen equals twenty-five opinions from twenty individuals. The explanation of individuals saying that either two or three-plow tractors and general-purpose tractors are the next development is simple but not surprising. In the next few years the two or three-plow tractor will increase in sales, but the general-purpose tractor will then come into its own.

Comments by these trained agricultural engineers will be interesting; a few are quoted as follows:

"A one-plow tractor (referring to the development of a general-purpose tractor) is in the horse zone and the prospect will not enthuse tractor buyers."

"I am rather pessimistic about the general-purpose tractor. It is like the general-purpose cow; it doesn't do anything very well."

"I believe that the present type of tractor will be further developed, but the main development of future tractors will be along the line of general-purpose machines that can be used in nearly all farm operations. While the present type of tractor can be regarded as a successful field machine, as far as plowing and general operations of that nature are concerned, it is far from satisfactory for other field operations, particularly those dealing with hay and corn growing."

"My judgment would be that what the farmer is going to want in the future is a general-purpose tractor that is good for belt work, that will handle at least two plow bottoms in the field under adverse conditions and can be used for cultivating, cutting grain with the binder, disking, plowing, and perhaps seeding and harrowing."

"It seems to me that the ultimate development in tractor construction is that they should do both plowing and cultivating, also mowing, pulling or carrying binder, seeding and practically all operations. I believe this tractor should have a special equipment designed for it; for example, it might possibly carry the mower and binder and furnish power for operating directly from the power unit on the tractor."

"I believe that the next big development in tractor construction will be a general-purpose tractor to which may be attached necessary implements, the implements being less expensive probably than present horse-drawn implements. In this connection I am inclined to think that we may see development in a three-row corn planter and cultivator."

"I believe that there is a big need for a general-purpose tractor which will pull two 14-inch plow bottoms and which can be used for cultivating row crops. It seems to me that a tractor of this nature would be very popular among the farmers."

"I expect to see the development of a general-purpose tractor which can be used successfully for plowing and for the cultivation of intertilled crops. It will be impracticable to make this tractor heavier than to furnish sufficient weight to pull a two-bottom plow. This type of a tractor will find a wide use in the corn belt. Some of the more recent experimental models would indicate that this general-purpose tractor is now within sight."

Some broad reasons exist for the conviction that a general-purpose tractor is the next development in the tractor industry:

1. The general-purpose tractor is a logical development in the evolution of machinery methods towards increasing the individual's capacity by controlling more power and larger machinery.

2. Planting seedbeds, cultivating row crops, harvesting most crops, except wheat, and miscellaneous hauling are important farm operations less efficiently handled than seedbed preparation because general-purpose tractors are not available.

3. Row crops occupy greater acreage than grain crops and are worth over a billion dollars more. Farming row crops lacks in efficiency because suitable mechanical power in the form of a general-purpose tractor is not yet available.

4. Labor conditions on the farm are such that extra labor for cultivating and harvesting which usually overlaps is expensive and hard to get. A general-purpose tractor will greatly relieve this situation.

In designing a general-purpose tractor, plowing and belt-work should be kept in mind as well as cultivating and mowing. The general-purpose tractor, in my opinion, should pull two 14-inch bottoms under most conditions, operate a 20 or 22-inch thresher, mow a 6, 7, or 8-foot swath, or pull two mowers if desired, and plant and cultivate two or three rows at a time.

Overcoming Sales Resistance to Modern Barn Equipment an Engineering Problem*

By W. B. Clarkson

Mem. A. S. A. E. Research Engineer, King Ventilating Company

SINCE the world began, the commercializing of a new idea has, in its early history, been compelled to run the gauntlet of abuse, criticism and satire. Stories of the exploits of airmen and submarine crews are today accepted as scientific facts. Only a few years ago our fathers got many a thrill in reading Jules Verne, while today his writings would be very tame reading.

Twenty-five years ago the metal cow stanchion was a new thing, which farmers generally pooh-poohed at; they opined that the new fangled contraption was no good, and when a forward looking, progressive dairyman with a vision of cow comfort invested in metal stanchions, he became the butt of ridicule in his neighborhood, and even his best friends would say, "A fool and his money are soon parted."

But the "new contraption" forged its way ahead through sheer merit until, in a comparatively short period, it became firmly established as a necessary part of the floor arrangement in every well-equipped dairy barn.

No one ever has been "sold" on the price of a new service or an article of merchandise when first introduced; the price is always too high, and the selling organization who pioneers the marketing of a new product is always confronted with the necessity for justifying the price of such an article for service. This is always the chief thing to overcome in the early history of its sale.

Consider the twine binder, as an example; everyone who has had experience in marketing that commodity soon after its invention, will recall the buyer's argument of "too much money." Eventually, the binder became standardized in design and price so the farmer needing a binder knew about what he would have to pay before starting to town to make his purchase. He only needs to consider the question of quality and service, and he will usually buy one of the standardized machines well known to have these elements back of it, in spite of any temptation of a cheaper price for a comparatively unknown binder.

Cow stanchions are rapidly becoming standardized in the same way, and while there is yet a much wider variation in design and price than is the case with the binder, the salesmen of barn equipment do not have to meet this sales resistance, caused by price ignorance, as they did a few years ago. Stanchions, pens and related parts are well enough standardized in price so the buyer has the opportunity of a large field of selection in which to purchase the equipment best suited to his ideas of quality and service. He is past the point of thinking that all stanchions are too high priced, because he knows that the price is regulated by free competition between the various manufacturers.

I will not attempt in this brief paper to discuss sales resistance caused by the farmer's financial problems during the last few years of depression; it is perfectly obvious that when times are good for the farmer he is just as free a buyer as any other class, of the things he needs to carry on his farming operations.

A prominent barn equipment manufacturer makes the following statement: "A few years ago it was necessary to sell the farmer on the idea of up-to-date barn equipment, the work was largely educational and it was sometimes no easy task to convince him that steel equipment would pay big in reduced depreciation, reduced labor cost, and increased milk yield. Today the average farmer seems to appreciate the need of this kind of equipment and sales are held up only through lack of his ability to buy automobiles, electric lighting systems, radio outfits, field machinery, and several dozen other things, including barn equipment, all of which he feels he must have. Just at present we are not meeting with any very definite sales resistance other than the shortage of money with the farmer. So while there is still much educational work to be done, we feel that with the farmer in better shape financially, and with fewer people in different lines of business after his money, the same as we are, there would be mighty little difficulty in selling him barn equipment."

One factor in the present sales resistance to the distribution of farm equipment is that many farmers have not yet awakened to the fact they can no longer rest with the easy assurance that the rise in the value of their land, in relation to other commodities, will assure them of a good increase in their financial statement at the end of the year, even though they fail to make anything in their actual farm operations.

Farmers Should Understand the Economic side of Modern Farm Equipment

One of the most important duties of agricultural educators is to teach the farmer the economic principles which must be observed by anyone who successfully conducts a business and sells its finished products on a market in which the demand does not increase more rapidly than the supply. It is a well-known fact that today most of the products of the farmer are not subject to an increased demand warranting dependence on the speculative returns from agricultural investment.

The principles of financial engineering are receiving a great deal of attention in all phases of industry, as evidenced by the extensive comments of the engineering press on Goldman's "Financial Engineering." A large part of the problem of overcoming sales resistance in the sale of farm equipment, lies in the presentation of the economics of the investment in farm improvements.

Every installation of farm building equipment, as well as every building, carries with it a certain amount of capital equivalent to that required at the beginning of a period of years to pay for the service which the improvement is to render. From this viewpoint this "capital equivalent" to a "cheap" improvement is more than it is on an improvement made on a quality basis. The demonstration of this principle is well worth the time and study of every agricultural engineer.

Ventilation applied to the farm buildings, as a commercial proposition, has several years ahead of it yet before it will be developed to the position where barn equipment now occupies in the farmer's mind.

Sales resistance in farm building ventilation is much less today than it was nearly two decades ago, when the first factory organization entered the field in an endeavor to commercialize this idea. And yet there is still a long road to travel, before the average farmer realizes the vital necessity of a well-appointed ventilating system to be applied to every building in which he houses livestock.

The educational work necessary to get this commercialized farm building ventilation idea well started was a much bigger job than the average man realizes, except he has had experience of a like character in his own career. There is much work ahead for those who are interested in educating the farmer's mind in this direction.

For many years there have been ventilating systems installed in dairy barns, all of them being made up according

*Part of the 1924 Report of the A. S. A. E. Committee on Farm Buildings Equipment.

to the individual idea of the owner of the building or the idea of some man in whom he had confidence. No two of these systems were alike and very few of them designed and installed by men with any previous experience, and in each of these cases the owner of the building took his own chances as to the successful operation of the system. Today there are several manufacturers in the field selling ventilating systems to the farmer, each with his own ideas about the results to be secured and the character and quality of the service to be rendered, but all of these manufacturers are combining in educational work that is rapidly convincing the farmer that good ventilation is a necessary and economical investment.

Right at this point, however, the prospective buyer of ventilation may become confused, not knowing which way to turn. One group with metal ventilators for sale in addition to a lot of other articles manufactured from sheet metal, is interested in selling him "cupolas." A second group, the country carpenter, does not like to work with sheet metal and in some districts, even at this late day, we find this class advocating the lumber cupola. A third group is interested in the sale of barn equipment and includes in their line a metal ventilator which they will sell to the farmer included with his barn equipment bill, and since it is necessary for them to draw a floor plan showing how to place their equipment in his barn, they offer him, as an added inducement, the services of their planning department which will design a ventilating system included in his plans, free of charge, which he may turn over to his carpenter so that a ventilating system built of lumber may be installed according to their plan. A fourth group is found in the extension departments of the agricultural colleges, plus the institute workers who lecture at farmer's short courses. To the everlasting credit of this last named class be it said they are persistent seekers after truth; and the field covered by them is vitally important and necessary to the upbuilding of agriculture.

However, just a short time ago some of the last named group were preaching to the farmer about "How cheap he could build a silo," describing in detail just how the farmer can purchase the material and do the work himself, thus saving the cost of high priced labor and providing himself with a silo "just as good for half the money." (Of course, the farmer's time isn't worth anything, and no doubt he would be out of a job unless he found something like this to do.)

In the past the policy of agricultural extension workers, judging by the fruit of their labors, seems to have been not "how good," but "how cheap" should the farmer carry out his building operations.

The extension work of the last year or two indicates that we seem to be coming to the end of this cheap era in farm building construction and are looking forward to an era when "quality" rather than "cheapness" is to be emphasized. The agricultural colleges, the U. S. Department of Agriculture, the farm press, and various other extension agencies are combining in the educational publicity emphasizing the necessity for good ventilation.

Benefits of Proper Ventilation Can Be Put on a Dollars and Cents Basis

The influence of proper housing conditions, as they are produced by quality engineering service in ventilation, is often neglected in the minds of farmers, because the returns are not immediate but are rather of a nature which influences most the permanent value of the investment in every husbandry enterprise. This permanent value may be appraised by a comparison of the ultimate outcome of the whole, when a complete ventilating system is installed, with the results that are likely to be experienced without the system.

For example, it has been found that the hay above the loft floor of an unventilated barn is often spoiled to a depth of one and one-half feet, by its having become saturated with moisture from the stable. Often there is another lot of hay spoiled beneath the purlin plate where the water has dripped from the roof, and again more along the outer walls of the barn.

Considering only the first of these items, in a barn 34 by 60 feet, 3060 cubic feet or 4.37 tons of hay are involved. At $15.00 per ton, a loss of $65.55. The thing that we are emphasizing here is that it is important that this liability be completely removed, and before it will be removed, its amount from a financial standpoint must be established in the minds of farmers.

Here we have a good problem in finance, to determine the present cash value of the equipment which will affect this saving over a period of, say twenty years. According to Goldman, the capital thus evaluated by the earning power of this equipment is,

$$E = \frac{A}{R} \times \frac{(1+R)n-1)}{(1+R)n}$$

where "A" equals the annual saving, "R" the rate of interest and "n" the number of years.

Solving this equation, where "A" equals $65.55. "R" equals 6 per cent and "n" equals 20,

$$E = \frac{\$65.55}{.06} \times \frac{1.06^{20}-1}{1.06^{20}} = \$751.87$$

The actual saving, within the twenty year period is much more than this, and, if invested at interest, the amount would again be much larger, but the above computation shows us what it is worth to us today to have the equipment that will produce such economic results.

While we cannot hope, in this discussion, to make a complete appraisal of the value of a ventilating system as computed from its results, I believe I have outlined a feasible method of overcoming the sales resistance in the distribution of all classes of farm equipment, as it can be done by education.

This brings us to the point of what, in my opinion is causing the greatest amount of sales resistance in the mind of the farmer regarding the question of farm building ventilation, and I believe the case is stated fairly.

The work of the Committee on Farm Building Ventilation of the American Society of Agricultural Engineers has been the greatest single agency in developing the standardization of farm building ventilation during the last decade and this committee has just begun to reach some definite results.

The present chairman of this committee, in conjunction with other workers, in the last three or four years has accumulated much fundamental data for the United States Department of Agriculture which, when published and made available to the general public, will do more to stabilize or standardize farm building ventilation than any other factor we can name. Naturally, when that time arrives sales resistance will be materially reduced.

How can the average farmer, who does not pretend even a smattering knowledge of the physics or chemistry of this ventilation problem be expected to be other than "all up in the air" as he becomes interested in the investigation of this subject and finds a multitude of confusing ideas proposed by men who are not willing to back their judgment by assuming the full responsibility of good results from their advice.

To the few who have had experience there are some well-established fundamentals and this sales resistance could be materially reduced if the A. S. A. E. will work out these fundamentals and adopt a recommended practice at an early date.

How can we expect the buyer's sales resistance to be very much reduced until a reasonably fair "recommended practice" is adopted by this Society, all members of the Society then to work in accord with this recommended practice and a concert of action naturally then would result as regards the educational publicity given out to the public on this subject.

In the preparation of this discussion the author gratefully acknowledges the receipt of valuable suggestions from the following: C. S. Whitnah, associate engineer, King Ventilating Co.; Bertram Scott, sales manager, Louden Machinery Co.; E. E. Rogers, sales manager, C. A. Libbey Co., and F. B. Wells, sales manager, Olsen Mfg. Co.

Research Methods in Agricultural Engineering

Research activities in the agricultural-engineering field are presented under this heading by the Research Committee. Articles dealing purely with the manipulation of research methods and equipment are featured. Members are invited to discuss material presented and offer suggestions on timely topics

Research in Agricultural Engineering—1923*

By R. W. Trullinger

Mem. A. S. A. E. Specailist in Rural Engineering, Office of Experiment Stations, U. S. Department of Agriculture

THE PURPOSE of this report, as in previous similar reports, is to draw attention to the more prominent features of agricultural engineering experimentation, investigation, and research completed, in progress, or in process of formulation during the year at the state agricultural colleges and experiment stations, certain other state, federal, and private institutions, and certain foreign agricultural and engineering institutions.

No claim for completeness is made in this report the intention being rather to survey the outstanding works with a view to bringing out lines for further study and of drawing special attention to what appear to be important lines of inquiry neglected in certain studies which have been in progress for some time and to proper starting points for other studies. Attention is also incidentally drawn in certain instances to some of the factors governing the evolution of research in agricultural engineering.

As usual, the work in agricultural engineering completed, in progress, or planned during the year included the following general subjects: Farm machinery, farm buildings and structures, drainage, irrigation, farm water supply and sewage disposal, land clearing, materials of construction, and miscellaneous.

Farm Machinery

There is a record of at least thirty-two either specific or general farm machinery projects in operation at thirteen stations in the states of Alabama, Michigan, Arkansas, Iowa, Nebraska, New York, Montana, West Virginia, Minnesota, Indiana, California, Wisconsin, and Missouri. Several of the stations still have projects under as general a head as farm machinery. It is believed, however, that the majority of these more general projects have undergone splitting processes into projects of a more specific nature and are practically inoperative, except insofar as they support such specific features.

Tractors—The necessity for definite knowledge of tractor characteristics in relation to certain farming requirements and conditions has apparently caused the abandonment of much of the general tractor testing work in favor of certain more specific studies. Even the economic surveys of tractors have undergone somewhat of a change for the better, as indicated, for instance, by the work at the Alabama, Arkansas, West Virginia, and Montana stations in which analyses of failures have apparently brought out important points requiring serious study.

The well-known study of tractor motor air cleaners at the California station apparently solved the problem of air cleaners for certain conditions in California. But to show how one study, intelligently conducted, grows into other broader studies, it became evident that more should be known about air cleaners to meet conditions in general. This led the Alabama station to study the problem from the viewpoint of its general applicability, and the conclusion was drawn that the logical starting point of such a study is the dust itself, since it is obviously the factor most vitally concerned. A study was then undertaken to learn something first of the fundamental principles governing the existence and movement of dust in an air cleaner and under engine intake conditions, to serve as a basis of methods for its maximum removal from the tractor air intake within a given range of partial vacua caused by intake suction and within a given range of amount and of physical, mechanical, and chemical composition of the dust. As far as can be learned, the tentative conclusion drawn by the station and by one of the larger private research agencies, working in co operation, is that the air-floated dust causing trouble is of colloidal fineness, and that after so called decolloidization or flocculation it is subject to control by known mechanical principles. The problem apparently now is to determine the factors governing the flocculation of air-floated dust under such conditions. While the above statement of progress results may not be absolutely accurate, it serves, on the other hand, to indicate an effective way of bringing agricultural engineering facts of universal application to light. The purpose of the work mentioned is evidently not to show what method of dust removal of those known and available is the best, but to indicate the principles which, when embodied in any air cleaner, will cause the maximum dust removal under the conditions imposed.

Preliminary studies of tractor characteristics have also indicated the importance of the problem involved in the traction of wheel tractors. Much experimental work has been done at great expense by several private commercial concerns with different kinds and types of tractor lugs. Such work has also been in progress at the Indiana, Michigan, Nebraska, and Alabama stations according to the records and probably at several other stations. In some cases, such as the Indiana station, the work is a continuation of that conducted for some years. These works have served to indicate the complexity of the problem, but owing to the rather general failure to yield much universally applicable information, the Alabama station has undertaken a study of the fundamental factors influencing the traction of wheel tractors. It is quite significant to note that the main premise adopted is that traction is primarily a function of soil conditions and secondarily of the design of the tractor wheel, a fundamental conception apparently overlooked by other investigators. It is planned first to determine what soil factors govern and influence traction and then to determine the factors in tractor wheel design necessary to meet these soil factors.

The results from this project, while yet inconclusive, have so far indicated definite relations between traction and such soil factors as bearing value, resistance to penetration, and shearing strength. Hardness, cohesive, adhesive, frictional, and puddling properties, tenacity, and plasticity are other soil factors which have assumed considerable importance in this work. The results indicate further that the distribution of impulsive forces in soils may be quite accurately determined. Compacting of soil slightly increases traction, the greatest increase being observed under quite wet conditions. Clay

*1923 report of the A. S. A. E. Committee on Agricultural Engineering Research.

permits better traction than sand, except under extreme moisture conditions. The point of greatest efficiency or permissible slip is not constant, occurring later in dry, loose soils than in moist, compressed soils. An interesting feature of the experimental procedure in this subject is that a close relationship has been established between the traction developed by a slowly rotating wheel when advancing and the force exerted by a stationary rotating wheel. The problem of traction in soil under such treatment has thus resolved itself primarily into one of soil dynamics and the influence thereof on traction. It may be noted in connection with this project that the A. S. A. E. Committee on Tractor Testing and Rating states that until standard methods are available for computing and evaluating the soil factors governing traction, drawbar, and other testing work for rating purposes will have no accurate basis for comparison.

Other tractor projects have been in operation at many of the stations, notably the Nebraska, Iowa, Montana, Minnesota, and California stations. The studies at the California station on the relation of side draft and tractor hitches and on the tendency of tractors to rise in front are particularly worthy of mention, and illustrate how effectively mechanics of engineering and sometimes the principles of pure science can be brought into such work, frequently as deciding factors.

As testing work pure and simple the Nebraska tractor testing work apparently has little research standing. However, a careful analysis and intelligent interpretation of the large amount of data made available has yielded some new basic relations and principles of a general nature, which should influence the trend of further studies and perhaps aid in the ultimate standardization of tractor design. Some most interesting and important information on the interrelations of tractor rating, belt speeds, weight distribution, tractive efficiency, wheel slippage, piston displacement, and fuel and water consumption has been obtained in this analysis.

Another interesting but more general tractor study has been in progress at the experiment station at Lyallpur in the Punjab of India. The problem is one of cultivation rather than of tractors, but it has brought out the fact that of the makes of tractors at present available the wheel tractor is a better and cheaper type for plowing on hard, firm soil, while the track-laying type is the better for work on light, sandy soils or on any soils in small areas. Studies in Java indicate the futility of attempting the cultivation of rice and sugar cane soils with anything but cable-drawn outfits.

The work of the Committee on Tractor Field Machinery should have an important bearing on the future development of tractors, especially if conducted on the basis of an accurate preliminary knowledge of what each machine should do. The requirements of tractor field machines, collectively, form the main basis for studies of specific characteristics of farm tractors.

Tillage Machinery. Considerable work on tillage machinery has been conducted during the year, much of it continuing work which has been in progress for several years. The majority of these studies have dealt with factors influencing the draft of plows and disk harrows, and almost without exception the results have indicated the influence of the soil as a more or less unknown factor of primary importance. The well-known plow draft studies at the Iowa station, for instance, virtually eliminate the plow and constitute apparently a tacit admission of the primary importance of soil mechanics as the controlling factor.

Plow draft tests at the Nebraska, California, and Missouri stations and disk harrow tests at the California, Nebraska, Missouri, and Iowa stations also have indicated the importance of a better preliminary knowledge of the ways in which soil properties influence the operation of tillage machinery.

With this in view, the California station is planning a project on the measurement of the mechanical characteristics of soils, the purpose evidently being to provide a rational basis for the development of tillage machines. The preliminary studies have indicated that shearing and compressive strengths and the factors governing friction between soil particles and metal surfaces are the characteristics of soils primarily influencing the operation of the metal parts of tillage machines through the soil. For the friction determinations, polished and flat or nearly flat circular rings, made of metals such as are used for the working parts of tillage implements, are to be placed upon flat spaces of soil, loaded with weights to stimulate pressures actually met in practice and revolved about the central axis. The torques necessary to start and maintain motion through a small angle are to be measured and all other measurable data such as density, moisture, humus, and silica contents, etc., of the soils are to be taken simultaneously. The shearing and compressive strengths of the soil are to be determined by measuring the forces required to cause the soils to yield when subjected to shearing and compressive stresses. Draft tests of plows are to be run simultaneously in the same soils, the purpose obviously being to simulate practical field conditions in the theoretical studies as nearly as possible. It is believed that if this study is so conducted as to bring out the factors and principles governing friction between metal surfaces and soils and the actual shearing and compressive resistances to the passage of tillage implements through the soil, much will have been accomplished toward providing a sound basis for the development of tillage machines.

The Alabama station is attempting to develop an even more fundamental conception of the influence of the soil factor on the operation of traction and tillage machines. On the basis that seedbed preparation and cultivation as well as traction are processes, the efficiency of which depends upon meeting the mechanical properties of the soil with suitable equipment, it is considered desirable to establish universally applicable fundamental principles regarding soil dynamics so that, for instance, the results of a tillage study in California soils can be translated into terms of Alabama soils. The study has so far brought out that the important soil dynamic factors involved include resistance to penetration, shear, and pulverization, adhesive and cohesive properties, bearing strength, hardness, state of tilth, mechanical and mineralogical composition, specific gravity, humus content, absorptive power, frictional characteristics, and moisture limits for optimum tillage conditions. The studies apparently aim to evaluate these factors so that singly and in logical combinations they can all be considered in a manner commensurate with their importance in the development of tillage machinery design.

Several of the stations have found that this work can not be effectively coupled as a whole with standard agronomic methods and classifications, due to the fact that the evaluation of many of the factors mentioned has been made by the agronomy people with an entirely different point of view from that of the agricultural engineer. This is taken to indicate the ultimate necessity for an entirely new classification of soils and their properties on the basis of engineering requirements. The studies at the U. S. Bureau of Standards on methods of measuring the plasticity of clays and by the British Society of Engineers on the physical properties of clays, with special reference to engineering requirements, are quite significant in this connection.

The California station also has devised a tentative method for measuring and standardizing the state of tilth of soil in connection with tillage studies, especially those on deep tillage implements. This method involves the use of different meshed screens placed one above the other, and yields data which, when graphically expressed, indicate the states of tilth of different soils and the tendencies of tillage operations in influencing tillage conditions.

There are at least twenty projects on different phases or tillage in operation at twelve different experiment stations. In nearly every case some phase of seedbed preparation is involved, the primary consideration being the influence of different methods of tillage upon the production of proper tilth conditions for certain specific crops. It would seem that many tillage studies might be effectively coupled with tillage machine studies, the resulting combined studies having for their object the development of tillage machines and methods which will produce definite required degrees of tilth in certain soils for certain specific crops or crop rotations. Obviously, a knowledge of what constitutes tilth of a certain

desired degree in a soil is the first consideration. After this is known a knowledge of the other soil mechanics factors which govern the production of such a degree or state of tilth must inevitably follow.

The importance of consulting the soil specialist in this work is evident, owing to the further fact that studies such as, for instance, those being conducted at the Oklahoma station on the effect of lime and organic matter upon hardpan subsoils, at the Minnesota station on the first breaking of peat lands, and at the Rothamsted Experimental Station in England on the influence of liming of soils on their resistance to plowing, indicate that certain treatments tending to modify the physical and chemical composition of the soil may also tend to reduce its resisting influence to tillage to a minimum. It is easy to see wherein such processes if intelligently manipulated may materially influence the trend of tillage methods and ultimately of tillage machine design.

Lubrication. Considerable study has been conducted during the year on the lubrication of internal-combustion engines, with particular reference to the requirements of tractor and truck engines and stationary farm engines. The U. S. Bureau of Standards has been conducting perhaps the most fundamental studies on lubrication in its work on friction testing of lubricating oils and on the reclamation of used petroleum lubricating oils. The Department of Science and Industry of Great Britain has brought out the value of such solid lubricants as graphite, talc, soapstone, mica, flowers of sulphur, and white lead. Special attention has been given to the use of graphite in a deflocculated condition in oils for use in the lubrication of internal-combustion engine bearings and cylinders. The results as a whole indicate the desirability of using only a small amount of graphite in such oil, usually less than 0.35 per cent, but under such usage engines appear to start more easily and with greater freedom. The Royal Society of Great Britain has studied the characteristics of cylindrical journal lubrication at high values of the eccentricity to bring out methods of determining shaft wear in bearings and lubricant viscosity. Several of the experiment stations are considering different phases of tractor motor lubrication, among them being the Wisconsin, Texas, and California stations. Apparently the Wisconsin station is continuing its study of the influence of kerosene fuel on tractor lubrication, while the work at the California station is aimed primarily at the reclamation of used tractor crankcase oil.

Undoubtedly the problem of tractor motor lubrication is quite complicated and is far from being solved. For some reason it has been left mainly in the hands of manufacturers of lubricating oils. Thus engineers are placed in the doubtful position of adapting tractors to available lubricants rather than of specifying the oils required to meet specific conditions of operation of individual tractors. It would seem that more thought might profitably be given to the formulation of a plan of study of the subject to provide rational bases for specifying definite physical and chemical properties of lubricating oils for tractor motors for certain definite conditions of service.

Carburetion. Carburetion is so intimately related to fuel characteristics, and fuels are so variable and uncertain as to uniformity of composition as to make it quite difficult to bring studies therein down to a very definite basis. The engineering experiment station at Purdue University has been studying the effect of speed on mixture and other carburetion requirements. The progress results have indicated that the change of speed of automotive engines does not affect the mixture ratios required to any marked degree when the temperatures are high enough for good carburetion and the compression ratio is the same. On the other hand, one of our larger private institutions has shown that in actual practice it is well to depend as little as possible upon the cylinder heat and temperature to complete the vaporization of the fuel. These examples of apparently partially contradictory results indicate the complexity of the problem of carburetion, and argue the importance of further preliminary study of the fundamental details of carburetion as a basis for development.

Fuels and Combustion. Fuels and combustion have been subjects for considerable study during the year and apparently much progress has been made.

The engineering experiment station at Purdue University has been studying internal-combustion-engine characteristics under high compressions using ordinary gasoline without detonation. The important fact was brought out that automotive engines designed to give a uniform cooling of the combustion chamber walls will permit the use of much higher compression ratios than those at present employed, with a consequent gain in power and economy.

Studies at Cornell University on the influence of proper timing of the ignition on the functioning of internal-combustion engines showed that spark advance is governed by the relation of the explosion time to the speed of rotation of the engine. It was found in this connection that one-half the rise of pressure during combustion occurs substantially at three-fourths of the explosion time, thus indicating the numerical basis for the relations of explosion time, engine speed, and optimum spark advance. It was further found that fuel mixture density does not affect the explosion time and that dilution with exhaust gas is the factor requiring a spark advance as the engine is throttled. The slowing of combustion by dilution was found to be about proportional to the cube of the mass dilution ratio. Detonation apparently changed the combustion habit as if it produced an abnormal top to the combustion.

Studies conducted in Great Britain on the pressures developed in gaseous explosions indicated the importance of placing the spark in the center of the combustion chamber and of polishing the interior surfaces of the combustion chamber. Increasing the density of the mixture slightly increased the time of explosion and the ratio of the maximum absolute pressure to the initial pressure.

The studies of the U. S. Bureau of Standards on economic motor fuel volatility have shown that on the basis of amount of accomplishment per barrel of crude oil, the advantage among the fuels lies with that of lowest volatility when used under summer conditions. Studies under winter conditions with four fuels of different volatilities showed that at low speed and temperature more of a less volatile fuel was required to give a maximum power mixture than of a more volatile fuel. No large differences in fuel consumption of the high and low volatile fuels were observed in constant speed tests. The rate of crankcase dilution was greater with the less volatile fuels under all conditions and the circulating water temperature had the greatest single influence upon the rate of dilution.

Experiments with a farm engine conducted at the Carnegie Institute of Technology using a fuel made by the catalytic oxidation of kerosene and a fuel of similar character made by the oxidation of gas oil showed that the oxidized kerosene, having a lower boiling range than the raw materials, developed approximately the same power as ordinary kerosene, in spite of the fact that its thermal value is one-eighth less. It also showed lower detonation tendencies.

Studies at the Mellon Institute of Industrial Research on the use of acetone in composite engine fuels showed that acetone alone is an excellent fuel, easy to start with, does not freeze, and does not detonate under a pressure of 180 pounds per square inch. It can be mixed in all proportions with various other engine fuels and in small amounts minimizes the deposition of carbon and detonation of heavy hydrocarbon fuels.

Comparative engine tests by the U. S. Bureau of Mines with crude, acid refined, and silica gel refined motor benzols showed that crude motor benzol can not be used satisfactorily in an internal-combustion engine, but that the acid refined or silica gel refined benzols develop no engine troubles and are satisfactory for use therein, provided the gum-forming constituents have been removed. Variation in the air fuel ratio had no definite influence upon the quantity of gummy deposits formed.

Tests by a private institution with a fleet of vehicles showed that motor benzol gave about 10 per cent better general results than gasoline.

Studies conducted in the French African colonies showed that peanut and sesame oils have a higher calorific value than palm and copra oils, and compare quite favorably in this respect with gasoline and benzol. Palm oil used in a tractor gave as good results on plowing as kerosene but at a somewhat higher fuel consumption. The possibilities of these cheap internal-combustion engine fuels for tropical climates appear quite promising.

Other Farm Machines. Other farm machines besides tillage machines, tractors, and their accessories have received a certain amount of attention during the year. The Wisconsin station has continued its mowing machine investigations indicating the power losses due to worn parts and bearings and dull knives.

The Canadian experimental station found in studies of the combined reaper-thresher in Saskatchewan that the cost of harvesting was reduced but that the degree of ripeness necessary to the satisfactory use of the combine resulted in a high percentage of soft wheat. While storage losses were low, the problem apparently is to perfect a practical method of bin curing. The development of an electrical method for this purpose would seem to have some promise.

The British Ministry of Agriculture has been engaged in studies of the mechanical thinning and harvesting of turnips. The preliminary studies of the objects to be accomplished and of available machines indicate the advantage of mechanical over hand labor methods, and show that the greatest possibility for development of such methods lies in the double or multi-row machines.

The agricultural experiment station at Wageningen, Holland, has developed a method for balancing threshing drums and other high-speed machinery, which consists in the use of one bearing as a center of rotation and another non-elastic bearing moving freely between two checks at a regulable distance apart. In case of an uneven distribution of the weight in the drum a clearly perceptible rattle occurs, and the quantity of overweight at any point due to uneven distribution is determined by measuring the centrifugal force produced by such overweight.

The machinery draft tests at the Missouri station have progressed into a study of the factors affecting the draft of wagons. It has been found that on roads of good brick, poor brick, cinders, wet gravel, and burned clay, the wider tires give the heavier draft, while on all other roads the narrower tires give the heavier draft.

A private institution has shown in studies of motor truck wheels that the average wear of the tires mounted on metal wheels is about 13 per cent greater than that of those mounted on wood wheels. Studies of truck rear axles showed that, while the maximum shaft stresses are practically the same for semi-floating and full-floating axles, the shaft in the full-floating axle can be made lighter and that a higher factor of safety should be employed in the semi-floating axle, since the bending stresses are continually reversed.

The work of the Committee on Stationary Farm Engines of the American Society of Agricultural Engineers has indicated a decreasing demand for stationary farm engines during the past three years, and has emphasized the importance of a more intimate knowledge of the farm power requirements of stationary engines as a basis for their further development.

The New York (Cornell) station has an economic survey in operation of farm motor trucks in New York State. It is hoped that this survey will be carried out far enough to show specifically wherein motor trucks can be developed to better meet farming conditions.

It is understood that work on the development of cotton spacing machinery is still in progress at the Arkansas station.

Interesting studies have been conducted by the dairy industries of the Dahme district in Germany on the comparative values of steam and central station electrical energy as sources of power in the dairy. The results of extensive studies indicate that electrical energy is in general the more expensive and that steam power plants accomplish on the average about 10 per cent more per unit of fuel used. Similar tests on the use of electricity and steam for threshing were much in favor of the latter, the total relative cost being only half that of electricity.

Studies by the Leather Belting Exchange to determine which side of an oak leather belt has the highest transmission capacity showed that under average service tensions the capacity of the flesh side averaged from 58 to 68 per cent of the capacity of the grain side.

The New York (Geneva), Illinois, Connecticut Storrs, Texas, and South Dakota stations have projects on milking machines which, it is understood, are confined to the animal husbandry departments. It is believed in some such instances co-operation with the agricultural-engineering departments in further work might be profitable, especially where it is desired to improve the efficiency of milking machines. The study at the Texas station, for instance, on the practicability of the milking machine, while productive of quite valuable results, has been conducted apparently from the viewpoint of the animal husbandman alone. While his viewpoint is the logical place to begin such work it has apparently been attempted to meet his requirements with available methods and apparatus only. The results show, for instance, that with the mechanical milking apparatus available, it is possible to produce certified milk, but it requires much more attention and care than to produce equally clean milk by hand. It would seem that co-operation with the engineer might take this work beyond the comparative into the investigational and developmental stages, with a view to increasing the efficiency of milking machines and ultimately of perfecting them.

A final example of farm machinery investigation which should interest agricultural engineers is the work at the Colorado station on methods of handling hay in the state. This work has so far apparently been limited to a consideration of methods and equipment for curing, stacking, and protecting alfalfa hay and seems to be in its preliminary stages. A problem evidently exists, and it is encouraging to note that work has been started with a consideration of the requirements of the thing most vitally concerned, the hay itself.

Obviously, a clear, logical starting point is just as important in studies of farm machinery and accessories as a definite objective or a logical plan of procedure, and the progress in these respects in farm machinery studies is quite encouraging. In addition, it is evident that comparative tests of available machines can no longer be considered of any more than incidental or temporary importance in most cases of the development of a machine to accomplish a certain thing, and the importance of developing a machine to meet conditions rather than forcing conditions to meet the requirements of some machine available is even more plainly evident.

Farm Structures

The rather general activities at many of the state colleges and experiment stations on farm structures for several years have served the purpose of providing a broad general background and of bringing out the fact that in many instances the problems in farm structures requiring engineering treatment present conditions of a more or less special nature, offering opportunities for investigations immediately adapted to the situation.

It is significant to note that in 1922 there was a record of only seventeen projects of study on farm structures at the experiment stations and that during the past year a record has been obtained of only twenty-one such projects at nine stations in the states of Alabama, Arizona, Michigan, Iowa, Minnesota, Wisconsin, Kentucky, Indiana, and California, and at one insular station. This is taken to indicate a recognition on the part of many stations of the quite limited utility of broad general projects on the subject, and of efforts on the part of others to undertake the development of structures to meet certain specialized conditions.

General Structures. The Iowa station has apparently been the leader in this work. The silo, hog house, dairy barn, and farmyard equipment studies at the Iowa station are rather well known. The physical and chemical studies begun in 1912 on the relative durabilities of thirty-five brands of commercial three-ply roofing have shown that the less

durable materials are those having a high volatile content. A mineral surface of sand, gravel, asbestos, or mica materially improves the durability of roofing. Exposure to the sun is apparently the most destructive influence and resinous knots in the sheeting are particularly destructive. These studies of commercial materials, while apparently comparative in nature, are significant in that they have been so conducted as to bring out the causes of deterioration of prepared roofing materials and of means for reducing the tendency to deteriorate under such causative influences.

Studies begun at the Iowa station in 1914 on making silo walls constructed of porous materials impervious have shown the effectiveness and superiority in this respect of bituminous material carefully applied to the surface by first sizing with a solution of the bitumen and then applying a hot layer. This treatment not only resists the action of the silage, but has little tendency to peel or scale off. In addition, observations begun in 1910 at the station have indicated the effectiveness of double walls in preventing the freezing of water in masonry water tanks constructed on silos. Attention is drawn to these cases as illustrations of the fact that the right way to undertake such studies may frequently be the simplest way.

The studies of self-supporting barn roofs and of livestock feeding and management equipment at the Iowa station are so well known as to need no discussion. Similar work covering several phases of the subject is being conducted at the Alamaba, Michigan, Minnesota, and Kentucky stations.

Heating and Ventilation. Considerable interest has been awakened recently in the heating and ventilation not only of dwellings and animal shelters but of crop storages. Projects on these subjects have been reported during the year from the Iowa, Minnesota, and Wisconsin stations and a study on the heating and ventilation of homes is in operation at the Minnesota station.

The work on animal barn ventilation by the U. S. Department of Agriculture, perhaps the most comprehensive of its kind, is still in progress. It has established as a fundamental conception that the animal to be housed is the thing most vitally affected by heating and ventilation systems, whether artificial or natural, and that, therefore, the requirements of the animal as to heat and fresh air should be made the starting point for all such studies.

The department has also shown that the factors influencing the desired temperatures and degrees of ventilation in animal shelters, in addition to the heat and fresh air requirements of the animals themselves, are insulation, tightness of construction, and amount of air space each animal is expected to heat. Studies conducted in this connection by a private institution resulted in the establishment of a mathematical basis for determining the thickness of insulation required to prevent sweating on cold surfaces under various conditions of temperature and humidity.

Studies conducted by the Department of Science and Industrial Research of Great Britain on the transmission of heat by radiation and convection, with particular reference to the influence of temperature, partitions, air spaces, and nature of wall surfaces on radiation and natural convection within closed chambers showed that the actual temperature of surfaces has a marked influence on the quantity of heat transmitted for a given temperature difference. Heat losses by convection increase more quickly than the first power of the temperature excess, a power of 5/4 seeming generally very satisfactory. Heat losses by convection are least in the horizontal position facing downward. A floor reduces the cooling of a vertical surface by about 4 per cent. The heat transfer by convection from unit area of surface across a closed vertical air space is independent of the height and width of the space. Studies by a German engineering experiment station on the heat conductivity of brick wall work and roof construction showed that such conductivity can not be adequately expressed by a single factor.

Studies of types of roof ventilators at the University of Minnesota indicated the superiority of the so-called rotary siphoning type.

Crop Storage. The development of structures for the storage of crops is quite a problem in some localities. The importance in such work of a careful preliminary consideration of the heat and ventilation requirements of the crop and of its behavior under storage conditions as a basis for the development of storage buildings can not be too strongly emphasized.

Studies of potato warehouses at the Michigan station began with a consideration of the ventilation, temperature, and moisture requirements of the potato itself and of its behavior as regards rotting under storage, and proceeded ultimately to the development of warehouses with suitable ventilation systems for Michigan conditions. Successful storage was found to depend upon the maintenance of a dry atmosphere and a low temperature in the storage house, and of a movement of air through as well as around the potato pile. A temperature of from 33 to 38 degrees fahrenheit was sufficiently low and bins not wider than eight feet nor deeper than ten feet, and kept some distance from the outside walls, permitted the proper ventilation.

Studies by the U. S. Department of Agriculture showed that all of sixteen different varieties of sweet potatoes were susceptible to decay by one of the two organisms most commonly found under storage house conditions. Two of the varieties more resistant to this organism were susceptible to decay by the other one at temperatures of from 20 to 22 degrees centigrade. Studies at the California station on the storage of root crops showed that the factors influencing the keeping of such roots as mangels, sugar beets, rutabagas, and carrots in a dry condition are in order of importance, ventilation, date of storage, relation of storage space to ground surface, and presence or absence of straw before covering with dirt. Studies at the Arizona station brought out the importance of grading of sweet potatoes to a uniform size as a factor in the prevention of spoilage in adobe store houses.

Studies of the storage of apples at the Iowa and Michigan stations indicated the importance of proper ventilation in the control of rots of some of the more important apple species. The studies at the latter station also showed that temperature is one of the most important factors in the keeping of apples. It was found that in air-cooled storages it makes little difference whether a storage is partially underground or entirely above ground. At least one square foot of intake area in the ventilating system is necessary for each seven hundred cubic feet of storage capacity, while the outlet flues should have a combined area of about two-thirds of that of the intake area.

These studies indicate that the development of crop storages calls for intelligent co-operation between the agricultural engineer and the crops and crop disease specialists.

Farm Dwellings. The heat, ventilation, and moisture requirements of persons are the factors for primary consideration to provide a basis for the selection of heating and ventilating equipment and apparatus and proper materials of construction for farm dwellings. In this connection the University of Illinois in studies of the humidity requirements of artificially heated residences has shown that a room at 69 degrees fahrenheit will be comfortable if the relative humidity is maintained at a value of from 35 to 45 per cent. A relative humidity of about 40 per cent is considered to be as high as it is practical to maintain in residences.

Studies at the Colorado station on the heat transmission of commercial wall board showed that the average co-efficient of heat transmission varied from 0.73 b. t. u. per hour per square foot per degree fahrenheit difference in temperature for actual thickness of beaver board to 1.01 for sheet rock wall board. Four other types of wall board had coefficients varying from 0.78 to 0.81. Interesting results have been obtained by the Department of Science and Industrial Research of Great Britain in studies on the efficiency of low temperature coke in domestic heating apparatus especially sitting room and kitchen grates. Interesting studies conducted at the University of Minnesota have shown that the effect of pressure on hot water circulation in a small gravity hot water heating system is very slight.

(To be continued in the June issue)

Survey of Agricultural Engineering Progress

A review of current literature on engineering as applied to agriculture prepared monthly by Robert W. Trullinger, Mem. A. S. A. E., specialist in rural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Nitrogen Formation in Sewage Digestion Tanks, Bach and Sierp (Centralblatt fur Bakteriologie, Protozoologie, Parasitenkunde und Infektionkrankheiten, Jena, 2. Abt., 58 (1923), No. 19-24, pp. 401-411, fig. 1; 59 (1923), No. 1-4, pp. 1-7.) Studies with digested sludge from an Emscher tank to determine the origin of the nitrogen in the gases from such tanks, and especially to test the theory of Groenewege that such nitrogen results from the denitrification of nitrites in sludge, are reported.

The results showed that during the anaerobic decomposition of nitrogenous organic matter elementary nitrogen is set free but that, owing to the lack of oxygen, nitrates are not formed. Where digested sludge in different dilutions and in layers of different depth was allowed to come into contact with air, there was a progressive formation of nitrites. A layer of scum on the surface hindered such nitrification by excluding the air. While it is considered possible that the nitrogen in the tank gases may be the result in part of the nitrification of nitrites formed before anaerobic conditions were produced by scum formation, everything indicates that the main part of such nitrogen is derived from the breaking down of nitrogenous matter under anaerobic conditions. Nitrite formation in sewage was found to be impossible without the unhindered entrance of air and the complete decomposition of the organic matter present.

Some of the chemical and bacteriological technique involved in these studies is briefly discussed.

Some Factors Which Affect the Plasticity of a Paint, E. C. Bingham and A. G. Jacques (Indus. and Engin. Chem., Washington 15 (1923), No. 10, pp. 1033-1036.) The results of a study conducted at Lafayette College of the factors which influence the plasticity of paints are presented.

These showed that as the grinding of the pigment in oil progresses the yield value at first decreases, but after 30 hours becomes constant. The mobility under the same conditions at first increases, passes through a maximum, and then decreases more and more rapidly. The maximum was found to occur after about 30 hours.

On measuring different concentrations of pigment suspended in oil, the yield value-weight concentration curve was found to be linear except at low concentrations. All concentrations exhibited a yield value, that having zero yield value being apparently independent of the nature of the medium. The mobility-weight concentration curve was also linear, and the concentration of zero mobility was apparently independent of the nature of the vehicle. Silica and lithopone had very different plasticities at the same weight concentration. When compared at equivalent volume percentages, however, the mobilities were nearly the same, and the yield values were not very different.

A comparison of blown oil and acid-refined linseed oil at the same concentration of pigment showed that the mobility fell off in presumably the same ratio as the fluidity of the oil, but the yield value was independent thereof. Polar colloids, such as aluminum stearate, had a very slight influence on the mobility but exerted an extraordinary effect in raising the yield value. It was difficult to grind a pigment into pure mineral oil having the same fluidity as linseed oil, and still more difficult to make a satisfactory plasticity determination on the resulting suspension. However, 0.2 per cent of oleic acid deflocculated a suspension and lowered the yield value about 80 per cent, while the mobility remained unchanged.

Moisture exerted a prodigious effect on the plasticity of paint, 0.5 per cent of moisture raising the yield value from 90 to 3,450, and at the same time reducing the mobility to one-fourth of its former value.

Oxidation and polymerization were found to affect the fluidity of an oil. It is thought that the fall in the mobility on long grinding may be attributed to one of these causes. A paint ground in an atmosphere of carbon dioxid had a yield value three times as high as when ground in air.

Hygienic Aspects of Use of Sewage Sludge as Fertilizer, A. Wolman, (Engin. News-Rec., New York 92 (1924), No. 5, pp. 198-202.) In a contribution from the Maryland State Department of Health, foreign and American regulations relating to the use of sewage sludge as fertilizer are summarized and recent experimental data presented.

It is shown that existing practice in this and other countries indicates that sewage sludge should not be applied to crops that are to be eaten raw. However, recent laboratory data have shown that if sewage sludge is held in a sludge digestion tank for a period of not less than ten days, its application to the soil as a fertilizer may be carried out without detriment to the public health through the possible dissemination of vegetable-borne disease.

Regulations governing the disposal of wet sludge to farmers for fertilizing purposes are recommended, the features of which are that only such sludge shall be delivered to farmers as has undergone digestion for at least ten days, and that sludge shall be used on ground only before crops are planted and shall not be sprinkled over or brought into direct contact with growing vegetables.

Principles and Practices of Upkeep Painting. (Philadelphia: E. I. du Pont de Nemours & Co., Inc., 1923, pp. 200, pls. 6, figs. 38.) The purpose of this book is to cover in simple fashion modern painting practice for all types of exterior and interior surfaces. It shows the reasons for decay and deterioration, describes proper methods to follow in conquering these destructive forces, indicates the part that paint and varnish have in upkeep work, and emphasizes the importance of using high quality materials for all painting purposes. It contains the following chapters: The importance of paint and varnish in the industrial world, modern paint and varnish making, superiority of ready-mixed paint, what is varnish, let the paint manufacturer prepare your specifications, woods and their treatment, causes of decay, value of practical tests, defects of paints and varnishes, proper finishes for wood surfaces, preparation of the surface for painting, general methods of application, exterior wood surfaces and their protection, treatment of interior wood surfaces, painting and preservation of metal surfaces, preparation of the metal surface for painting, application of the material, exterior metal surfaces, interior metal surfaces, treatment of concrete and cement surfaces, exterior concrete and cement surfaces, interior concrete and cement surfaces, light-reflecting finishes for interior walls and ceilings, plant standardization systems, zoning systems in industrial plants, spray painting, brushes and their care, how to operate a paint shop, and periodical paint inspection and guide to its performance.

Outline of Ground Water Hydrology with Definitions, O. E. Meinzer (U. S. Geological Survey, Washington, D. C., Water-Supply Paper 494 (1923), pp. IV+71, figs. 35). This report represents an attempt to outline the different concepts involved in ground water hydrology and to define the corresponding terms. The main subjects dealt with are atmospheric, surface, and subsurface waters and wells, the most of the space being devoted to subsurface water.

Notes on the Proper Placing of the Slots in Imhoff Tanks, J. R. Downes (Public Works, New York, 54 (1923), No. 11, pp. 363-365, figs. 4). A summary of a large amount of data, some of which was obtained at the New Jersey Sewage Experiment Station, is briefly presented, indicating that the slot of a two-story tank should be placed with due consideration for the progress of digestion which will have been attained at the time when the fresh solids, without shrinkage, have accumulated to a depth equal to the distance between the hopper and the slot, and that the horizontal dimensions of the tank should be such that the solids will be evenly distributed in so far as possible.

Concrete Roads and Their Construction. (London: Concrete Pubs. Ltd., 1923, 2, ed., pp. XVI + 210, figs. 15.) This is a description of the concrete roads in the United Kingdom, together with a summary of the experience with this form of construction gained in Australia, Canada, New Zealand, and the United States. It contains chapters on concrete roads in industrial works and on private estates, international road congress at Seville, mechanical devices for making concrete roads, concrete curbing, specification for concrete roads, memoranda for concrete users, and the use of concrete for road accessories.

The Economics of Highway Grades, T. R. Agg (Iowa Engin. Expt. Sta. Bul. 65 (1923), pp. 48, figs. 37). A tentative economic theory of highway grades is presented, which is based upon the analyses of a great amount of data bearing on the subject and extensive field investigations which have been in progress for three years.

The results indicate that where the annual traffic may reach several million tons the actual value of the fuel saved by grade reduction may reach very significant sums. The value of lost time due to excessive grades is an even larger sum, especially where the volume of commercial vehicle traffic is large.

It has apparently been established that momentum grades on rural highways are economical both from the standpoint of fuel and time, and that under certain circumstances less fuel will be required on a road with an undulating grade line than on one with very flat grades. It is also shown that no economy results from the reduction of long grades of less than about 3 per cent, and that short grades may reach 8 per cent without adversely affecting either fuel consumption or average speed. An interesting fact brought out in the fuel consumption tests was the marked saving in fuel that results from coasting downhill with the motor declutched.

Sand Bed Studies at Montebello Water Filters, Baltimore, I. J. R. Balis (Engin. News—Rec., 92 (1924), No. 13, pp. 516-522, figs. 9). Observations of the individual sand grains of a sewage filter with a camera lucida disclosed a gelatinous coating, the thickness of which affected the efficiency of the filter. Cracks, mud balls, and clogged places were found to be due largely to the loose settling of the filter after washing, and to subsequent settlement while filtering. An excessive gelatinous coating around the sand grains caused the loose settling.

After several years of close physical and microscopic examination of the sand and experiments in the operation of the filters, it was found that the removal of a portion of the gelatinous coating by direct jet action of wash water applied through perforated pipes near the sand surface maintained the beds in a satisfactory condition during summer and winter. Due to the excess of the gelatinous film a larger sand grain was found to be preferable in summer, but in winter the film grew less vigorously and a smaller grain was desirable. The proper mean was found to be about 0.6 millimeter. The size, composition, and other characteristics of the grains had little influence on the thickness of coating formed if there was no force tending to remove it, but the size had a great effect upon the settlement. Due to abrasion in washing, size greatly affected the amount of coating that was retained on the grains.

The remedy for such troubles as the pulling away of the beds from the side walls, the formation of cracks and clogged places, and bacterial growths, when the proper sinze of sand was used, was found to be to prevent the formation of an excessively thick gelatinous coating or organic incrustation around the sand grains.

Economic Motor-Fuel Volatility, R. Birdsell (Jour. Soc. Automotive Engin., 14 (1924), No. 3, pp. 267-273, figs. 9). In a further contribution to the subject by the U. S. Bureau of Standards (E. S. R., 49, p. 887), progress data on the fuel investigation, including results obtained from acceleration tests made on the road and in the laboratory, are reported.

The tests described were conducted primarily to determine whether the rates of acceleration obtainable at any given temperature are different for fuels of high and low volatility and whether, when carburetor settings are such as to give maximum acceleration with each fuel, the fuel consumption under constant speed and load conditions will be greater with one fuel than with the other.

Under all conditions very nearly the same rate of acceleration was obtained with the fuel of low volatility as with that of high volatility, but under cold conditions more of the former fuel was required for maximum acceleration than of the latter. Maximum acceleration occurred at the carburetor setting giving the maximum power at 600 r. p. m. and full throttle. The tendency was also noted for the acceleration to become greater as the temperatures were decreased. This was due largely to the greater power developed under these conditions, and did not imply better fuel utilization. There was an appreciable lag in the acceleration with a lean setting. With a rich setting the engine showed a greater initial acceleration, but for the full range of the engine speed the greatest average acceleration was obtained with the maximum power setting.

Data on the design of the disk used to simulate the inertia of an automotive vehicle are appended.

Drainage District Assessments: A study of present practices in assessing benefits under the State drainage laws, G. R. Boyd and R. A. Hart (U. S. Dept. Agr. Bul. 1207 (1924), pp. 70). The established principles of drainage assessments and present practices in assessing benefits under drainage laws of different States are presented.

A special assessment is defined as a burden laid upon real estate to secure a special benefit to such property and a general benefit to the public at large. General benefits are defined as those which are enjoyed by the public at large and which are common to all the people of the community. The factors of special benefit generally include (1) the need of drainage or wetness of the land, (2) the amount of drainage or protection furnished, (3) increased healthfulness, (4) increased accessibility, and (5) the use which is being made of the property.

The three general methods of determining the assessments in use are the percentage, classification, and the actual-value-of-the-benefits methods. The first two methods are said to be either too complicated or too inflexible to allow the fixing of equitable assessments. The third method, which estimates the actual value of the benefits conferred and apportions the assessments accordingly, is required by the statutes of 14 States. It follows directly the theory of special benefits by determining the value of the benefits to accrue and uses the benefits as a basis for apportioning the assessments. It is considered to be much better than any other method now in use, and in addition is simple and readily understood. The use of this method is strongly recommended.

Cutting Down Curing Period for Concrete Roads, H. F. Clemmer (Engin. and Contract., Roads and Streets, 61 (1924), No. 2, pp. 283-290, figs. 5). The results of an investigation conducted by the Illinois division of highways on the use of calcium chlorid in the hastening of the setting of concrete in roads are reported. It has been generally proved that calcium chlorid when used in the proper amounts does accelerate set and secures same strength at the end of fourteen days as can be obtained from the use of the various wetting methods in twenty-eight days. Roughly, the action of this chemical is dependent upon its hygroscopic properties and its resulting ability to attract moisture from the air.

The investigations of the effects of external treatment showed that surface applications of dry calcium chlorid were far superior to the external use of solutions of the chemical. Specimens cured in this manner had a modulus of rupture much greater than those treated externally with 30 and 60 per cent solutions of calcium chlorid.

Studies of the properties of calcium chlorid applied externally to concrete led to the belief that the chemical served to prevent the formation of transverse cracks caused by shrinkage as a result of its property of maintaining the moisture content of the concrete at a high percentage during the first forty-eight hours. Further studies in the laboratory showed clearly that the concentration of the calcium chlorid used in curing is not the important factor in scaling, but that the degree of tamping is the main cause.

Treated surfaces showed an almost imperceptible wear after an abrasion test, while the untreated surfaces showed a distinct depth of abrasion under the same number of revolutions of the apparatus. Compressive and transverse tests made in conjunction with the determination of wear again demonstrated the superiority in strength of the chemically cured material. The early indications are that greater strengths of concrete may be secured by the use of external applications of calcium chlorid than by internal applications.

Roughness as a Factor in Pavement Life, A. T. Goldbeck (Engin. and Contract., Roads and Streets, 61 (1924), No. 2, pp. 206-316, figs. 12). In a contribution from the U. S. D. A. Bureau of Public Roads the causes and effects of road roughness are discussed in connection with measurements of impact on surfaces and of the effect of impact on stress in concrete roads. Devices for measuring roughness are described. The results so far obtained indicate in general that even a seemingly smooth road surface will have appreciable roughness and that the higher the speed the greater and the more frequent will be the impacts delivered to the surface by trucks. The rougher the road the greater are the impacts.

Viscosity of Lubricants at High Pressure and Temperature, M. D. Hersey. (Jour. Soc. Automotive Engin., 14 (1924), No. 2, p. 188, fig. 1). Data on the viscosities of a number of lubricants over a greater range of pressures and temperatures than has hitherto been attempted are presented. They indicate especially how the viscosity varies with the temperature at high pressures.

Irrigation District Operation and Finance, W. A. Hutchins. (U. S. Department of Agriculture Bulletin 1177 (1923), p. 56, fig. 5.) This bulletin outlines the history and explains the purpose and methods of operation of irrigation districts, with particular reference to the legal and financial features involved.

Comparison of Ideal and Commercial Carburetor Characteristics, C. S. Kegerreis. (Jour. Soc. Automotive Engin., 14 (1924), No. 3, pp. 286-301, figs. 21.) In the first part of a contribution from the Purdue University engineering experiment station, general information is presented to illustrate the ideal carburetor mixture requirements when using a fully developed acceleration device. In the second part computed data illustrate the carburetion requirements of various automotive vehicles for level operation and indicate the advisability of using straight-line mixtures. In the third part data are presented on commercial carburetors, the results of several devices are shown in detail, and the results of tests of twenty-three carburetors are reported. In the fourth part eleven devices are compared with the ideal carburetor at various speeds.

The desired characteristics, as established, are that the engine must develop maximum power at wide-open throttle, maximum efficiency must be maintained wherever possible, and proper acceleration must be provided when using economical mixtures. The carburetion requirements established are that vaporization and distribution must be correct in all cases. An average of the vehicles of the 1.25-inch carburetor class required nearly the same mixtures at the lower flow rates as those of the 1-inch carburetor class. The variation was mainly that slightly richer mixtures were required at the same flow rates. The 1.5-inch class was 7 per cent richer at certain flow rates. A straight-line mixture was found not to suffice for level road performance.

A. S. A. E. and Related Engineering Activities

Promoting Cooperative Relations Between College and Industry

SUBSTANTIAL progress was made in developing a real program for more constructive cooperation and better relationship in general between the farm-equipment industry and the agricultural-engineering departments of the state agricultural colleges at a joint conference of the Committee on Cooperative Relations of the American Society of Agricultural Engineers and a similar committee representing the National Association of Farm Equipment Manufacturers held in Chicago March 8. The A. S. A. E. was represented by J. B. Davidson, Iowa State College; O. W. Sjogren, University of Nebraska; and H. B. Walker, Kansas State Agricultural College. The N. A. F. E. M. was represented by R. B. Lourie, Deere & Company; H. W. Hirshheimer, La Crosse Plow Company; H. J. Barbour, Avery Company; F. A. Wirt, J. I. Case Threshing Machine Company; and H. J. Sameit, secretary of the N. A. F. E. M. Prof. Walker, of K. S. A. C., acted as chairman of the conference.

Preliminary discussion brought out the fact that the educational institutions desired to be of real constructive service to the farm-equipment industry since the advancement of agriculture depends to a great extent upon the intelligent use of farm labor-saving machines.

The conference then proceeded to the discussion of cooperative efforts along the lines of education, experimental and research work, economic relations, and the preparation of men for the agricultural industry. The educational discussion of the conference centered about Smith-Hughes work in vocational agriculture and the preparation of men to teach such work. It is apparent that agricultural engineers must accept a great responsibility in preparing men to teach farm mechanics subjects in rural high schools. To carry out the work of these teachers, the discussion brought out the fact that the local implement dealers should extend offers of cooperation in order to make the instruction of most value to the community.

Dealers and users schools which have been held during the past few years largely by individual companies may be made more effective if they are conducted in cooperation with the state college agricultural engineering departments. In fact, it was the concensus of opinion of those present that such schools, if held cooperatively, should be under the direct supervision of the institutions with the local dealers and manufacturing companies acting in a cooperative capacity. This does not mean that individual companies should give up the idea of their own schools, but in certain localities it may be more profitable for the manufacturing company and the state institutions to cooperate in these matters of education. The need of keeping the instruction educational instead of commercial was emphasized.

Increased cooperation in experimental and research work was quite generally agreed upon. The state colleges, through the agricultural engineering departments, should undertake research work dealing with fundamental problems of interest to the manufacturer and designer of farm equipment. Fellowships in farm machinery and equipment were suggested as a means of developing useful research work of particular interest to the industry. The manufacturing representatives requested more detailed information regarding the establishment of such fellowships and a special committee was appointed for this purpose.

The conference discussed the economic factors entering into the use and development of farm equipment. The need of more specific power units in agricultural economic studies was emphasized. It was the opinoin of the conference that agricultural engineering departments should cooperate more closely with the departments of agricultural economics to secure and develop data more useful in engineering methods of analysis. The problems in distribution of farm equipment brought out the need of improving the standards of the local dealers. It was believed that such improvements could be brought about by more publicity regarding the place of the local dealer in the community life and by working out systematic methods for interesting young men in this field of commercial life.

The apprentice method of inducting trained agricultural engineers into the farm-equipmnt industry was discussed at considerable length. The present situation in the industry is such that no general plan at this time seems likely of general adoption, although it was generally admitted that a logical plan must be worked out to be put into effect as quickly as possible The manufacturers expressed a preference for men trained in the technical field of the agricultural engineer. The A. S. A. E. representatives were requested to work out a standard form of application for the induction of such technically trained men into the business. In this connection a hope was expressed that the retail side of the industry might be benefitted by such a plan.

The following statements summarize the important points developed at the conference and these were agreed upon as a basis for further cooperation; all agricultural engineering departments should do everything possible to carry the proposed cooperation into effect:

I. Agricultural engineering departments at the state agricultural colleges should be ready—

1. To hold tractor and farm equipment schools under state supervision cooperating with dealers and manufacturers.
2. To address implement associations on problems of mutual benefit.
3. To help organize Smith-Hughes work and determine methods of cooperation between local dealers and teachers.
4. To request equipment on a loan basis with a definite policy regarding carrying charges and responsibility, and to be frank in asking companies to dispose of obsolete machines.
5. To carry on cooperative experimental work if requested, or to give reasons if this cannot be done, and why not.
6. To offer facilities for testing new machines in the field or to give reasons if this cannot be done, why not.
7. To establish fellowship in farm machinery and equipment.
8. To determine agricultural tendencies in their respective states with reference to types of equipment in the predominating types of agriculture.
9. To cooperate with agricultural economics departments in bringing about better energy factors in farm management surveys.
10. To assist in a better and more efficient system of retail distribution through a raising of standards of local dealers.
11. To prepare bulletins on better practices with common types of farm machines.
12. To prepare men for the implement industry and to work out application blanks and contracts for apprentice courses for the industry.

II. The farm equipment manufacturing industry should be ready—

1. To cooperate in holding dealers and users schools under state supervision.
2. To request representatives of agricultural engineering departments to speak at implement association meetings.
3. To cooperate with Smith-Hughes teachers in improving training in farm equipment.
4. To keep loaned equipment up to date.
5. To ask land grant institutions to undertake experimental and research work of particular interest to the industry.
6. To request use of college facilities in the development of equipment.
7. To finance and suggest fellowships in agricultural engineering research.
8. To request institutions to work out logical methods to determine the energy requirements of the various agricultural methods.
9. To study the retail problem with a view to working out a plan to make the local dealer of greater service to the community.
10. To adopt a logical method of inducting trained agricultural engineers into the implement industry.

Much Interest in Application of Electricity to Agriculture

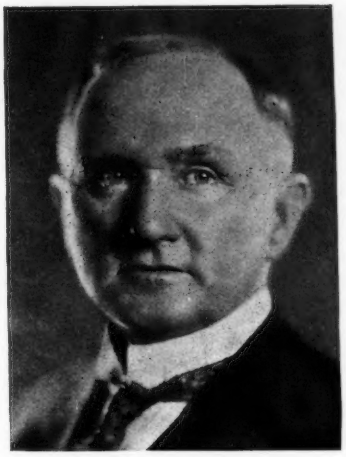
A GREAT deal of impetus was given to advancing the more extensive application of electricity to agriculture as a result of the meeting held April 9 to 12 of the Mid-West Section of the National Electric Light Association at Kansas City. Practically half a day of the program was devoted to this subject. Mr. Arthur Huntington, chairman of the Mid-West Section of the N. E. L. A. Rural Lines Committee, opened the discussion by a report of his committee. He described the organization and work of the national Committee on the Relation of Electricity to Agriculture, which is composed of representatives from the American Farm Bureau Federation, the National Electric Light Association, farm light plant manufacturers, U. S. Departments of Agriculture, the Interior, and Commerce, and the American Society of Agricultural Engineers. Mr. Huntington reported the plans of the committee, consisting of (a) a national farm power survey, (b) present practice in the use of electricity on the farm, (c) foreign practice in the use of electricity, and (d) experimental and research work. Discussion of the subject was led by President William M. Jardine, of the Kansas State Agricultural College, who explained the program as it has been outlined for the state of Kansas. It is hoped to establish in Kansas, as has been arranged for in several other states, an electrified community which will serve as a field laboratory, the purpose of which is to insure that the development of the application of electricity to agriculture shall proceed along sound economic and engineering lines. Members of the American Society of Agricultural Engineers who took an active part in this discussion were Prof. H. B. Walker, of the Kansas State Agricultural College, Prof. E. E. Brackett, of the University of Nebraska, Prof. J. B. Davidson, Iowa State College, and Prof. Mack M. Jones of the University of Missouri. Special emphasis was placed upon the importance of making the program fundamentally one of research and fact finding.

Booklet on Standardization

THE American Engineering Standards Committee has just issued a small but interesting book entitled "Standardization—What it is Doing for Industry." This describes how standardization is being carried on, first, in the individual plant, second, in industry as a whole, third, nationally on an inter-industrial basis, and, fourth, internationally. Copies of the booklet may be had by writing to the office of the American Engineering Standards Committee, 29 West 39th Street, New York City.

Dr. Mead to Head Reclamation Bureau

DR. ELWOOD MEAD (Hon. Mem. A. S. A. E.), professor of rural institutions at the University of California, has been appointed by Hubert Work, Secretary of the Interior, to be commissioner of the Bureau of Reclamation. Dr. Mead succeeds C. W. Davis, former governor of Idaho, who will become head of the new division of finance in the department.



Dr. Elwood Mead

Since last December Mr. Mead has been engaged with the special advisers on reclamation, who reported their findings recently on the new policy to govern reclamation projects. Secretary Work indicated that the appointment of Dr. Mead was necessary to carry out policies decided upon by the special committee from its inquiries. Dr. Mead will take up his duties at once and put in operation the new policy developed by this committee and the Secretary of the Interior, who will promulgate them as rapidly as practicable. Dr. Mead has received leave of absence from the University of California to take up his new duties. Regarded as one of the foremost irrigation engineers, he has served as state engineer of Wyoming, chief of irrigation and drainage investigations of the U. S. Department of Agriculture, and chairman of the rivers and water supply commission of Australia. He was until recently chairman of the California State Land Settlement Board.

Engineers Recommend Thorough Investigation of Muscle Shoals

NO disposition should be made of Muscle Shoals until a thorough investigation has been made by a joint committee of Congress, it is asserted by American Engineering Council in a report submitted to Chairman George W. Norris of the Senate Committee on Agriculture and Forestry.

The engineers find that the expectation of cheaper fertilizers immediately is unwarranted and that the synthetic process of nitrogen fixation has altered the whole situation. Exhaustive inquiry by an impartial technical commission is urged, A. E. C. offering its assistance in this task.

The engineering report, prepared by a special committee sitting in Washington, in response to a request by Senator Norris, was made public by the president of the Council, Ex-Governor James Hartness of Vermont. Addressed to Chairman Norris, it follows:

"Pursuant to your request under date of April 5, relative to the Muscle Shoals situation, American Engineering Council appointed a committee to examine the available data and facts and report thereupon.

"The committee so appointed found it impossible, in the time available and with the means at its command, to sift out from the mass of conflicting testimony and information, sufficient undisputed and determinable data upon which to base a sound engineering recommendation as to the disposition or use of the property.

"The committee was, however, unanimously agreed:

"First, that a joint committee of Congress should be constituted 'to consider offers, conduct negotiations and report definite recommendations' as advised by the President in his message to Congress delivered December 6, 1923.

(Continued on page 120)

Every Farm Needs Some

The Fifth Message of a Series to Dealers, referring to the Problems of the Farm Equipment Industry

THE continued use of worn-out and out-of-date equipment is costing the farmers of the United States millions of dollars annually. Carefully prepared statistics show that many farmers are paying, over and over again, for improved equipment they do not own. The United States Department of Agriculture says that over-repaired, inefficient machines and implements are losing their owners more than the cost of new tools, through scant yield and loss of labor and time in preparing seed beds, planting, cultivating, and harvesting the crops.

Mark what efficiency and the scrapping of old methods have done in the industrial world! American industry has advanced much faster than agriculture in the past twenty years. Our manufacturers compete successfully in world markets because they have kept production expenses down by an amazing development of labor-saving factory machinery. Europe, even with its low-wage scale, cannot compete with us because American high-priced labor, working with modern factory equipment, *distributes the manufacturing costs over large quantity production.*

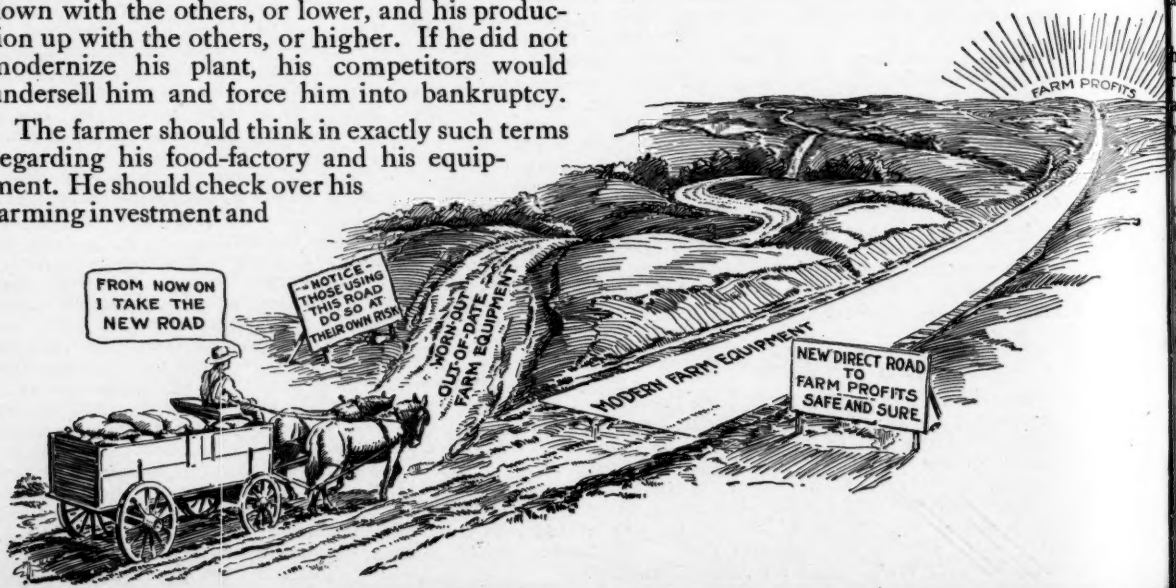
The wise American manufacturer does not hesitate to replace equipment the moment such equipment is out of date. He must keep his costs down with the others, or lower, and his production up with the others, or higher. If he did not modernize his plant, his competitors would undersell him and force him into bankruptcy.

The farmer should think in exactly such terms regarding his food-factory and his equipment. He should check over his farming investment and drop every old method and every old machine as soon as he has evidence that he could save or make more money with a newer method or an improved machine. He should learn, as every successful manufacturer has learned, that *the value of a piece of equipment should never be measured by its price but by what it will do for him—by what it will earn and save and make.* If he has reason to believe that new equipment costing $100 would save or make him an extra $100 or more in a season or two, he cannot afford to do without that equipment.

Help the Farms to Earn More

Greater profit on the farms can be made possible through careful planning and management, diversification, seed testing, fertilization, saving of labor and time, and increased yield. *Farm equipment is the big factor concerned in each of these details. It made agriculture great; it will make agriculture still greater.*

The man who must still be weaned from the primitive methods of fifty years ago is hopelessly out of the running in the march of progressive farming. His case is considered here only incidentally. The examples we cite deal more with *newer, better machine methods* over older machine methods. They emphasize 1924 over 1910 or 1900. They deal with equipment which, through long service and the passing of time, may have gone gradually out of date or grown inefficient.


FARM PROFITS
FROM NOW ON I TAKE THE NEW ROAD
—NOTICE— THOSE USING THIS ROAD DO SO AT THEIR OWN RISK
WORN-OUT OUT-OF-DATE FARM EQUIPMENT
MODERN FARM EQUIPMENT
NEW DIRECT ROAD TO FARM PROFITS SAFE AND SURE

Modern Equipment

The modernizing of agriculture divides itself naturally under these four headings:

Replacements

Every farmer should take careful inventory of his machines, checking the ability of each to do economically the work it was designed to do. When he can replace worn-out, wasteful equipment with new, efficient types, it will be to his own best interests to make the change.

An old corn planter may be a liability instead of an asset. If it plants poorly, and cracks or misses only one kernel in ten, the *loss on 40 acres may run from 100 to 200 bushels.* This is more than enough to pay for a new planter.

The Extension Service of the State of Illinois in a recent letter said—"The testers in Illinois Cow Testing Associations have reported losses as high as $25 a month from inefficient cream separators." Iowa testers report identical conditions. Thousands of farmers would find it profitable to retire old separators and get new ones.

These are but two possible examples out of scores. Thus the farmer might go through his entire equipment, giving a clean bill of health when deserved, but plugging up the leaks where profit is being wasted.

Improved Methods

Very often when a machine is discarded the biggest economy will be found not in mere replacement by a unit of the same size but by a faster, improved, larger-capacity machine or method. It is essential that maximum work be done by mechanical aid. Labor must do *more* work in a given time.

Old plowing methods can often be profitably improved. It costs $30 less to plow 40 acres with a gang plow than with a walking plow.

In corn cultivation, a 2-row cultivator will do the work in half the time of the 1-row, not only saving many dollars but relieving labor at a time when farmers are busy with haying and grain harvesting. In the corn harvest, a mechanical picker will pick, husk and deliver into a wagon four or five times as much corn a day as the average hand husker.

With modern haying equipment, a better quality of hay can be produced and stored easily, at less expense and with less risk to the crop. Many old 6-foot binders should be replaced with larger units, reducing the expense of harvesting and saving time when time is a factor of utmost importance.

These instances indicate what can be done when farming operations are brought up to date. The market offers a great variety of improved methods which have been produced to offset present labor costs.

New Equipment

The road to extra farm profit can often be found through the use of modern improvements that many farmers have been slow to adopt.

The silo is a prime need on every corn farm. It saves the 30 to 40 per cent of feeding value which is in the corn stalks and leaves, and which would otherwise be wasted. It provides a compact, palatable winter stock feed readily converted into beef and dairy products.

Manure evenly distributed by a manure spreader, applied to any crop, will mean an increased yield over hand spreading, saving time and eliminating much disagreeable work.

There are many kinds of barn equipment that farmers can use to advantage. One man who has used a litter carrier for twenty years writes—"It has saved us at least one hour a day besides making work so much lighter. The total investment was less than $100, yet it has paid for itself and saved $1,000 in labor."

In the corn belt, great economies can often be effected by the use of portable or bucket elevators.

In fruit cultivation, proper spraying with an up-to-date outfit will save 90 per cent of the possible yield.

The farmer who is feeding unground grain can cut his feed bills from 12 to 25 per cent by grinding.

Farm Power

Power farming presents tremendous possibilities for improvement in every phase of farming. Mechanical power must inevitably be adopted by the farmer who is seeking to bring production costs down to lowest levels.

The flexible, liberal power of the tractor clears the way to economies in many directions. It cuts labor costs. It works at full efficiency through all weathers and all hours. It means swift, timely work in plowing, seed bed preparation, harvesting, and threshing. Its flexible power is available both at drawbar and belt.

The great possibilities in the tractor are reflected in the small engine. Think of the work that might be saved on the engineless farms. A 1½ h. p. gas engine costs about 5 cents an hour to run, and for these few cents it will assume such farm tasks as pumping water, turning the cream separator, running the washing machine, etc. Larger sizes are available for sawing wood, grinding feed, baling hay, etc.

There is probably not a farm in the United States that could not be improved from a money-making standpoint by the purchase of some modern equipment.

Research Department

National Association of Farm Equipment Manufacturers

608 So. Dearborn Street, Chicago, Ill.

5-1-'24

A Richer Opportunity for

TWENTY-FIVE years ago electricity was a doubtful form of energy in industry. Today electric energy is an indispensable factor in thousands of mills and factories.

An enormous amount of research had to precede this development—research concerned both with the generation and distribution of electric energy and with industrial processes.

If farming is to be electrically conducted there must also be research to reveal the lines along which central stations may cooperate with farmers and along which manufacturers must develop electrical farm machines and implements.

NATIONAL ELECTRIC

Agricultural Engineers

In carrying out its plans the National Committee charged with the problem of studying rural electrification, will depend on facts gathered by state groups of farmers who will light their buildings, grind feed, churn butter, handle crops, pump water, and keep house electrically.

Already such groups have been organized in Minnesota, South Dakota, Alabama and Kansas. Electricity is now being supplied to them experimentally. Other states will be included in this great experiment, so that the conditions that must be faced on farms of widely different type and size will be accurately known.

Each of these groups is self-controlled, and each receives the technical guidance of its state agricultural college.

Thus agricultural engineers are cooperating with electrical engineers and farmers in gathering the facts which must be known before the principles of a sound policy of farm electrification can be established.

As the recommendations of the National Committee, based upon the results of state experiments, are made from time to time, and carried out, farming will have more and more need of such expert counsel as agricultural engineers can give. Hence the electrification of farms means a richer opportunity for those who have been trained to give technical agricultural counsel.

The National Committee in charge of the work is composed of economists and engineers representing the American Farm Bureau Federation, the Department of Agriculture, the Department of the Interior, the Department of Commerce, the Power Farming Association of America, the American Society of Agricultural Engineers and the National Electric Light Association.

A booklet has been published by the National Committee. Read it and pass it along to your neighbor. It will be sent free of charge. Write for it either to Dr. E. A. White, the American Farm Bureau Federation, 58 East Washington Street, Chicago, Ill., or to the National Electric Light Association, at 29 West 39th Street, New York City.

LIGHT ASSOCIATION

"Second, that no disposal should be made of any of the Muscle Shoals properties or rights until each joint committee of Congress shall have rendered its report.

"Third, that in no event should any disposition of the power plant be made that is not in substantial accord with the provisions of the Federal Water Power Act.

"In the course of its investigations the committee found nothing to justify the popular belief that the operation of the existing plants at Muscle Shoals will make substantially cheaper fertilizers immediately available, inasmuch as nitrates, however important, constitute but one of the three basic ingredients of commercial fertilizers, and consequently a considerable reduction in the nitrate cost would be reflected only to a slight degree in the cost of the marketable product.

"The committee further found that recent developments of the synthetic process of nitrogen fixation had materially changed the entire outlook in the art, and it is now quite possible that this process, for the use of which the so far unsuccessful Muscle Shoals Plant No. 1 was designed, may yet yield nitrate at a cost to compete with that obtained from Chile; and Plant No. 1, until recently considered a failure, may be the more valuable of the two constructed by the Government.

"The Administrative Board of American Engineering Council has carefully reviewed the work of its committee and endorses the findings and recommendations above set forth; and in view of the great importance of the questions involved and the much apparently contradictory information thereon presented to the Congress and to the public, the said Board would recommend and, as far as propriety permits, would urge that no disposition of the plants be decided upon until a thorough investigation can be made by a disinterested technical commission, and the Board hereby tenders its services to assist in the formation of such a commission if and whenever such assistance may be desired."

The 18th Annual A. S. A. E. Meeting

(Continued from page 100)

sion men are urged to attend the meeting and come loaded for a round-table discussion. The extension meeting will be preceded by a Dutch lunch at the College of Agriculture.

The convention headquarters of the Society during the meeting will be at the Lincoln Hotel. The following is a list of hotels in Lincoln and their location and rates:

Lincoln Hotel, Ninth and T Streets. Rates: $1.50 to $2.00 without bath; $2.50 to $3.50 with bath.

Lindell Hotel, Thirteenth and M Streets. Rates: $1.50 to $1.75 for single rooms without bath; $2.00 to $3.00 for single rooms with bath; $2:50 to $3:00 double rooms without bath; $3:00 to $4.00 double rooms with bath.

Windsor Hotel, 230 North Eleventh Street. Rates: $1 to $2.25.

Savoy Hotel, corner Eleventh and T Streets. Rates: $1.00 to $2.00.

Central Hotel, 1325 T Street. Rates: $1.00 for single room; $1.50 for double rooms, without running water; rooms with running water $1.50 for single and $2.00 for double.

Undoubtedly those members who intend to stay at hotels will want to make reservations at the headquarters hotel, the Lincoln. From the standpoint of committee meetings, conferences, etc., that different groups will hold during the meeting, the advantage of having reservations at headquarters hotel is obvious.

While the chairman of the Committee on Local Arrangements advises that they do not expect the city to be crowded at the time of the annual meeting, nevertheless it is suggested that those who plan to stay at hotels write in advance for reservations. Reservations should be made direct with the hotels.

For those who are driving to the annual meeting in automobiles and plan to camp out, if they will let Prof Sjogren know in advance, arrangements will be made for them to camp on the college grounds or, if desired, places at the city tourist camp can be found where more conveniences will be at the campers' disposal. The city tourist camp, however, is situated about two miles from the college campus.

Arrangements have been made to hold practically all of the sessions at the agricultural college campus, with the exception of the business meeting, which will probably be held in the Mechanical Engineering building, which is located near the hotel.

Those who desire to engage in a game of golf are requested to advise Prof. Sjogren in advance so that he may arrange to secure guest cards at the Country Club through the Chamber of Commerce.

Inasmuch as a large number of members will go to the annual meeting via Chicago, you can leave Chicago at 5:30 P. M. on the Chicago, Burlington & Quincy Railroad and arrive in Lincoln the next morning at 8:10.

A Correction

IN the paper entitled "Measurement of Seepage Losses in Canals," by O. V. P. Stout, appearing on page 82, of the April issue of AGRICULTURAL ENGINEERING, Mr. Stout's connection was incorrectly given. He is connected with the Cooperative Irrigation Investigations of the Bureau of Public Roads, U. S. Department of Agriculture, and of the division of engineering and irrigation of the Department of Public Works of the State of California.

New A. S. A. E. Members

C. P. Johnson, professor of rural engineering, College of Agriculture, Los Banos, Philippine Islands.

(Miss) Mary E. Keown, director educational department, American Washing Machine Manufacturers Association, 10 S. La Salle Street, Chicago, Illinois.

R. D. Marsden, senior drainage engineer, U. S. Department of Agriculture, 6105 Broad Branch Road, Chevy Chase, Maryland.

John K. Pike, electrical engineer, General Electric Company, Schenectady, N. Y.

S. E. Reynolds, research branch Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S. W. 1, England.

Applicants for Membership

John N. Arndt, investigator in grain dockage, U. S. Department of Agriculture, 3600 First Avenue South, Minneapolis, Minnesota.

Addison G. Bissell, general engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pennsylvania.

William A. Burrell, division sales manager, Central Illinois Public Service Company, 782 North Main Street, Canton, Illinois.

William O. Dunn, commercial manager, Illinois Power & Light Corporation, 3725 North Broadway, St. Louis, Missouri.

Hal B. Fullerton, director of agriculture, Long Island Railroad Company, Medford, Long Island, New York.

Claude D. Se Cheverell, assistant to president, Central Power Company, Grand Island, Nebraska.

George S. Williams, general superintendent, Central Maine Power Company, Augusta, Maine.

TRANSFER OF GRADE

Everette C. Easter, associate agricultural engineer, Alabama Polytechnic Institute, Auburn, Alabama.

James B. Kelley, professor of agricultural engineering, University of Kentucky, Lexington, Kentucky.

A. T. Logan, manager of ventilation department and vice-president of James Manufacturing Company, Fort Atkinson, Wisconsin.

George E. Martin, practicing agricultural engineer, Box H, College Station, Texas.

AGRICULTURAL ENGINEERING

Published monthly by the American Society of Agricultural Engineers

at the headquarters of the Society

54 North Avenue, Mount Clemens, Michigan, U. S. A.

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to the members of the Society, $2.00 a year, 20 cents a copy. Postage to Canada, 50 cents additional; to foreign countries, $1.00 additional. Entered as second-class matter, November 7, 1923 at the post office at Mt. Clemens, Michigan, under Act of August 24, 1912. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title "Agricultural Engineering" is registered in the U. S. Patent Office.

S. H. McCRORY, President RAYMOND OLNEY, Secretary-Treasurer

Vol. 5 JUNE, 1924 No. 6

CONTENTS

EDITORIALS....123

WHAT THE MEETINGS COMMITTEE SAYS ABOUT THE ANNUAL MEETING PROGRAM....124

PROGRAM OF THE 18TH ANNUAL A. S. A. E. MEETING....125

UTILIZATION OF ELECTRICITY IN AGRICULTURE....126
By E. A. Stewart

EXPERIMENTS IN PLOWING CUT OVER LAND....127

COMPARATIVE TESTS OF ROOF VENTILATORS....128
By W. G. Ward

PRESENT DAY TYPES OF FARM SEPTIC TANKS....130
By R. C. Kelleher

SOME SEWAGE DISPOSAL INVESTIGATIONS....131
By E. A. Stewart

FARMSTEAD ENGINEERING AT DELHI COLONY....132
By Max E. Cook

RESEARCH METHODS IN AGRICULTURAL ENGINEERING....133
—Research in Agricultural Engineering—1923
By R. W. Trullinger

SURVEY OF AGRICULTURAL ENGINEERING PROGRESS....136
By R. W. Trullinger

A. S. A. E. AND RELATED ENGINEERING ACTIVITIES....138

Statements of facts or opinions advanced in original articles, papers or discussions are not sponsored by the Society as a body. Original articles, papers, discussions and reports may be reprinted from this publication provided proper credit is given.

The Object and Scope of A. S. A. E. Activities

THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.

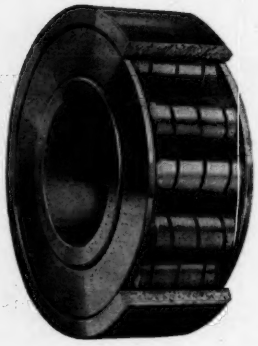
(b) Farm Structures—buildings and other structures and related equipment.

(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.

(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.

(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.

Member American Engineering Council



Don't hesitate to specify Hyatt Roller Bearings because they cost a little more—years of dependable service in the products of the foremost makers of tractors and implements prove that they are worth it.

HYATT ROLLER BEARING CO.
NEWARK · DETROIT · CHICAGO · SAN FRANCISCO

Buffalo
Pittsburgh
Huntington
Minneapolis
Cleveland
Philadelphia
Milwaukee
Worcester

HYATT
ROLLER BEARINGS